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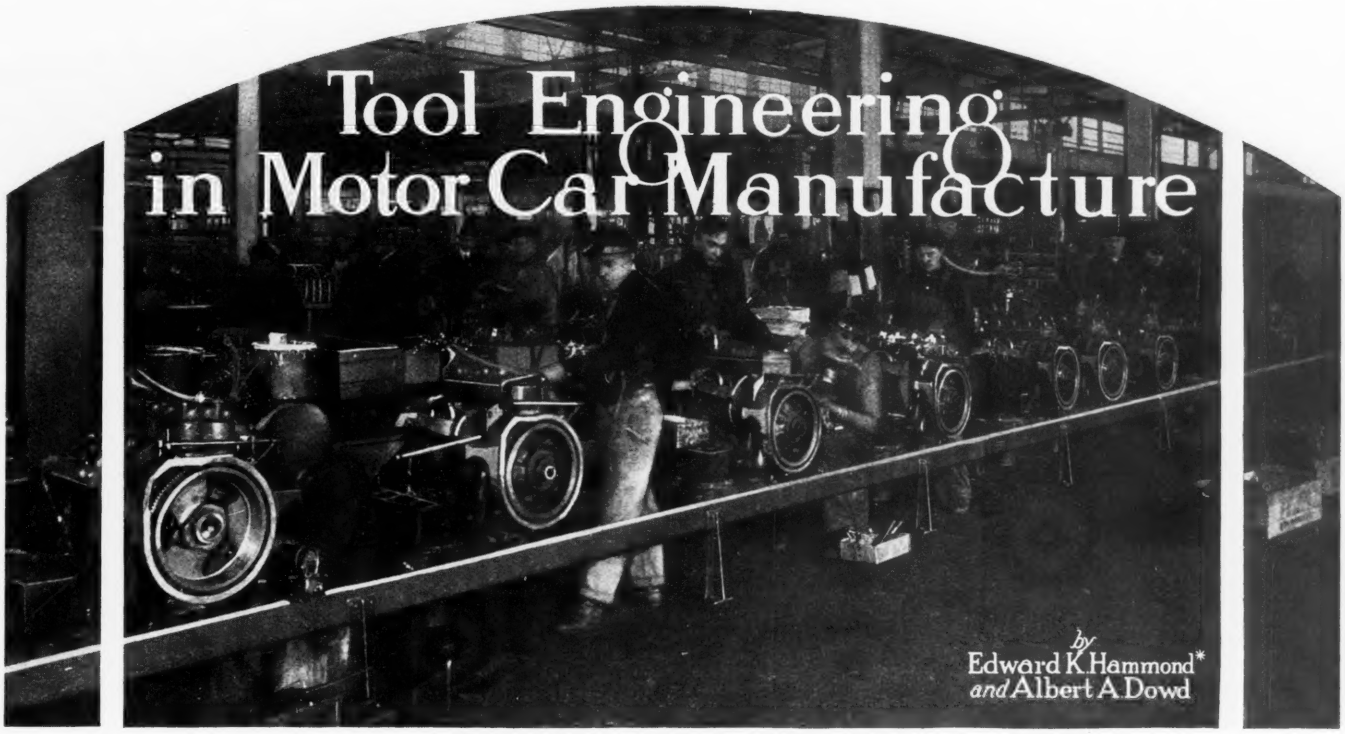

Tool Engineering in Motor Car Manufacture

by Edward K. Hammond* and Albert A. Dowd

The distinction between manufacturing and building machines is that manufacturing is generally understood to involve the quantity production of machine parts which can be assembled with little, if any, hand fitting, while building is understood to have reference to making a smaller number of parts which are fitted by hand. Manufacturing requires the use of special tools, jigs and fixtures; and the manufacturer's profits will depend to a large extent upon the care and skill with which the planning of machining operations and the designing of special tool equipments are carried out. The preliminary planning of machining operations has obtained wide application in the automobile industry, and the present article discusses the methods employed in planning; the conditions which govern the design of jigs, fixtures and special tools for each operation; and the principles involved in estimating production after the methods of machining have been decided upon and the design of tool equipments for these purposes has been completed. For the purpose of discussion, this article deals directly with the preliminary work involved in preparing for the manufacture of certain important parts of an automobile engine; but attention is directed to the fact that practically all the information presented is of a general character and capable of application to the interchangeable manufacture of a great variety of other products.

SUCCESS in any line of interchangeable manufacture depends to a large extent upon the care that is taken in planning machining operations and designing jigs and fixtures. This fact is shown by the unusually high rates of production and large returns from labor and investment in plant obtained in the automobile industry. Probably there is no line of manufacture in which the performance of machining operations along preconceived lines has found such wide application, and in which the work is done according to the actual requirements of the operation, regardless of what may be current practice on similar work. The man who looks after the work of planning operations and designing jigs and fixtures is generally given the title of tool engineer, and in order to handle this work successfully, he must have certain well defined qualifications. It is of the utmost importance for him to possess a wide knowledge of machine tools and methods of performing machining operations; and he must keep constantly posted in regard to the latest equipment used in the manufacture of interchangeable parts. The tool engineer must also be thoroughly familiar with the physical properties of all classes of metals used in constructing the product of the company by which he is employed, and with the cutting speeds and feeds which can be employed in machining these materials. Last, but not least, the tool engineer should be an experienced draftsman, and he should have sufficient knowledge of freehand sketching to enable him to express his ideas rapidly on paper.

When the design of a new car has been passed by the engineering department of an automobile factory and a decision has been reached to place it on the market, the first step in taking up the manufacture of this car will be to send blueprints of all parts to the office of the tool engineer so that he may study the design of each part, lay out the order in which the machining operations are to be performed, and design jigs and fixtures for these machining operations. For the purpose of discussion in this article, we shall assume a case in which a factory previously engaged in automobile manufacture has adopted a new design of engine to be used in a car that this company is about to place on the market. In such a case the factory will be provided with practically all of the machine tool equipment required for the machining operations, so that the work of the tool engineer will be confined to the planning of operations and the design of the necessary jigs and fixtures.

When blueprints of the motor parts have been received by the tool engineer, and he has been given instructions to proceed with the design of jigs and fixtures for these parts, his first step will be to refer to the design of corresponding parts of the preceding type of motor and the tools used for machining them. This is done to ascertain whether or not any of the tool equipment formerly used can be changed at a moderate cost to adapt it for use in the manufacture of parts of the new engine. It almost always happens that many of the tools can be utilized in this way, but attention must be paid to the fact that all automobile manufacturers are continually called upon to furnish repair parts for obsolete types of motors of their manufacture. Such parts are generally made in lots of about one thousand, and are distributed to the service departments of the company, which are maintained in most important cities. For use in the manufacture of these parts, at least one complete set of jigs and fixtures is kept on hand. Card files are maintained to show the position of these tools in storage bins, and the bins are conspicuously numbered so that any particular lot of tools can be easily located.

Importance of Cooperation Between Tool Engineer and Chief Designer

In starting his work, the first point considered by the tool engineer is the character of the parts to be machined and the method of holding which appears to be most suitable for each particular case. In order to secure the most satisfactory

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results, the tool engineer and the chief designer of the engineering department should work together. The reason for this is that the designer is not usually an expert on the performance of machining operations, and so he should secure the advice of the tool engineer in order to be sure that the design of all parts of the motor shall not only be perfectly suited to the service required of them, but that they shall also be made in a way which will enable them to be conveniently held while being machined. A few minutes devoted to conferences between the designer and tool engineer at specified intervals pattern shop, so that after the design has once been approved by the chief draftsman and tool engineer, they may be circulated through the factory with the assurance that no subsequent trouble will develop.

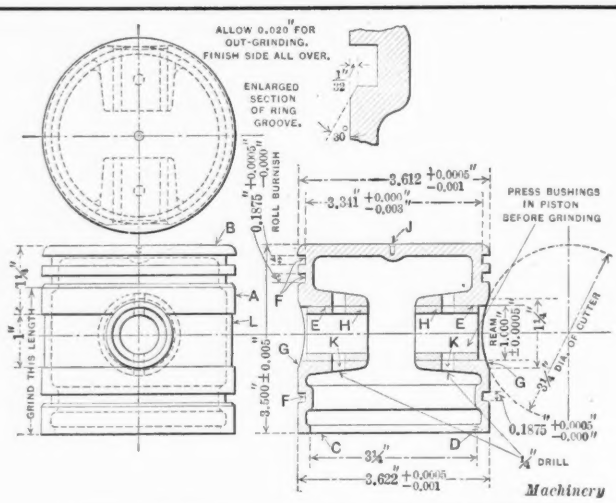
Subdivision of Tool Engineer's Work

It is a general principle of tool design that the method of procedure must be governed by the number of pieces to be produced, because it is obvious that a certain relation should exist between the cost of the jig and the amount of work to

TABLE I. OPERATION AND TOOL LIST FOR PISTON—COMPLETE FORM AS USED BY TOOL ENGINEER

Piece No. 5055

Name, Piston



Pattern No. M-18

Material, Cast Iron

Operation No.	Operation	Type and Size of Machine	Location Points	Tools, Fixtures and Gages	Tool Drawing No.	Tools Ordered, Date	Estimated Hourly Production per Machine	No. of Machines
1	Pickle to remove sand and scale	Pickling bath	....	Sulphuric acid	....	....	..	..
2	Rough-turn outside A and face end B	Semi-automatic chucking machine	Inside of cored surfaces	Expanding air chuck. Turret and cross-slide tools	F-2160 F-2161	9/3/15 9/5/15	28 ..	3 ..
3	Face open end C, bore and ream hole D	Turret lathe, 2 by 26	Outside machined surface	Soft jaws for 12-inch chuck. Two boring-bars—one reamer 3.250 inch	C-3612 C-3612	9/5/15 9/5/15	60 ..	2 ..
4	Drill wrist-pin hole E	Duplex horizontal drill	Faced open end and inside bosses	Drilling fixture. 15/16-inch high-speed steel drills	F-2162 Stock	9/8/15	72 ..	2 ..
5	Finish-turn outside A, face end B and rough out ring grooves F	Semi-automatic chucking machine	Open end	Draw-back chuck with pin through wrist-pin hole. Turret and cross-slide tools	F-2163 F-2164	9/11/15 9/11/15	35 ..	3 ..
6	Rough- and finish-ream wrist-pin hole E	Turret lathe, 2 by 26	Open end and drilled hole	Pot fixture. Locating bar. Rough and finish piloted reamers of floating type	F-2165 F-2166	9/13/15 9/13/15	60 ..	2 ..
7	Mill relief G around wrist-pin hole	Horizontal milling machine	Open end and drilled hole	Indexing fixture with stud. High-speed steel milling cutters 3¼ by 2 inches	C-3615 Stock	9/13/15	60 ..	2 ..
8	Press bronze bushings H into wrist-pin hole	Arbor press	Outside and drilled hole	Special fixture. Shouldered bar	F-2167 F-2167	9/15/15 9/15/15	100 ..	1 ..
9	Center-drill and countersink closed end at J	Sensitive drilling machine	Outside and open end	Special plate jig. Combination drill and countersink	C-3617 Stock	9/15/15	100 ..	.. ..
10	Drill oil holes K in bosses	Two-spindle sensitive drilling machine	Inside bosses	Jig plate with V-blocks to drop over bosses M. ¼-inch high-speed steel drills	F-2168 Stock	9/20/15	100 ..	1 ..
11	Cut wide oil groove L	16-inch engine lathe	Open end and center	Special nose-piece with driver. Wide forming tool	F-2169 A-1360	9/21/15 9/21/15	80 ..	1 ..
12	Rough-grind outside A of piston	Plain cylindrical grinding machine	Open end and center	Special nose-piece with driver. Grinding wheels—crystolon K-30. Limit gages	F-2172 Stock	9/21/15	30 ..	3 ..
13	Finish-grind outside A of piston	Plain cylindrical grinding machine	Open end and center	Special nose-piece with driver. Grinding wheels—crystolon K-30. Limit gages	F-2172 Stock	9/15/15	30 ..	3 ..
14	Rough-ream wrist-pin bushings H	Turret lathe, 2 by 26	Open end and drilled hole	Pot fixture (see Operation 6) Locating bar. Roughing piloted reamer	F-2165 F-2166	9/17/15 9/20/15	60 ..	2 ..
15	Finish piston ring grooves F	16-inch engine lathe	Open end and center	Special nose-piece with driver. Burnishing tools for grooves	F-2169 F-2169	9/22/15 9/22/15	40 ..	2 ..
16	Finish-ream wrist-pin bushings H	Bench	....	Holding fixture. Special reamer	C-3621 C-3621	9/25/15 9/25/15	80 ..	1 ..
17	Inspect	Bench	....	Special gages	F-2172	9/27/15	..	..

would often be the means of effecting large savings in the cost of manufacture, as it sometimes happens that many castings are made before it is found that they are of such a form that special means should have been provided for holding them. Had such a conference been held before the castings were made, it would have been an easy matter for the tool engineer to suggest the provision of lugs or recesses on the castings to engage clamps provided on the fixture. These conferences should be held before the drawings are sent to the be produced in it. But although the tool engiñeer in an automobile factory pays a certain amount of attention to this point, it is not a matter which concerns him so vitally as it does the tool designers employed in some other lines of manufacture, because the average automobile factory has such a large production that any reasonable expenditure is warranted, provided it furnishes a means of handling the work with the maximum efficiency. In the following article it is assumed that equipment is being provided for a shop which is to pro-

duce two hundred motors in a ten-hour working day. The tools are designed on this basis and rates of production are calculated with the view of determining the number of machine tools, jigs and fixtures which must be provided for each operation in order to secure this rate of production. The order in which the tool engineer handles his work is as follows: (1) Planning the order of operations. This includes a consideration of the effect of the design of each part to be machined upon the method of machining. (2) Deciding on what type of machine each operation is to be performed. (3) Selecting locating points on the work for each operation. (4) Designing the necessary jigs, fixtures and tools. (5) Making the tool drawings. (6) Estimating the rate of production that can be obtained for each operation, in order to determine the number of machines and tools that must be provided to produce the required number of parts. As each motor part is taken up, the tool engineer decides upon the best order in which to perform the machining operations and then makes out an operation and tool list, such lists being included in connection with this article for the large parts of an automobile engine. Table I shows the list made out for the piston, the form presented being the same as that actually used by a successful tool engineer. Other tables showing operation and tool lists for important motor parts have been somewhat condensed in order to present the information without taking up an unnecessary amount of space. In all cases, the necessary number of views of the part to be machined are presented at the top of the operation and tool list, to show all surfaces to be finished. In the present case, all finished surfaces have been marked by reference letters in order that they may be readily connected with the data presented in each table. Each operation and tool list gives all necessary information concerning individual machining operations, the types of machines used, the tools with which these machines are equipped, and the estimated hourly production per machine, together with the number of machines required to give a production of two hundred motors in a ten-hour day. The part number of the piece to which the operation and tool list refers is also given on the form to facilitate identification. By looking over these operation and tool lists, it will be evident that the most careful planning has been done to be sure that the method of manufacture adopted is well suited to the requirements of each case.

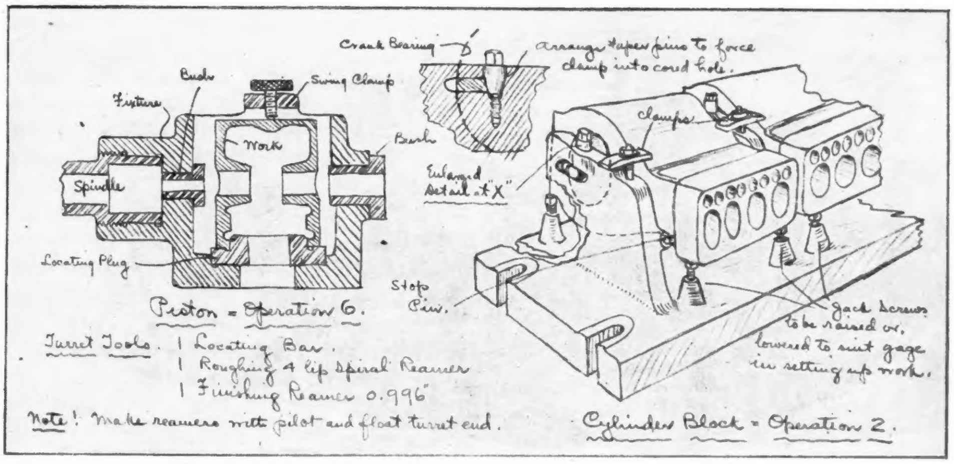
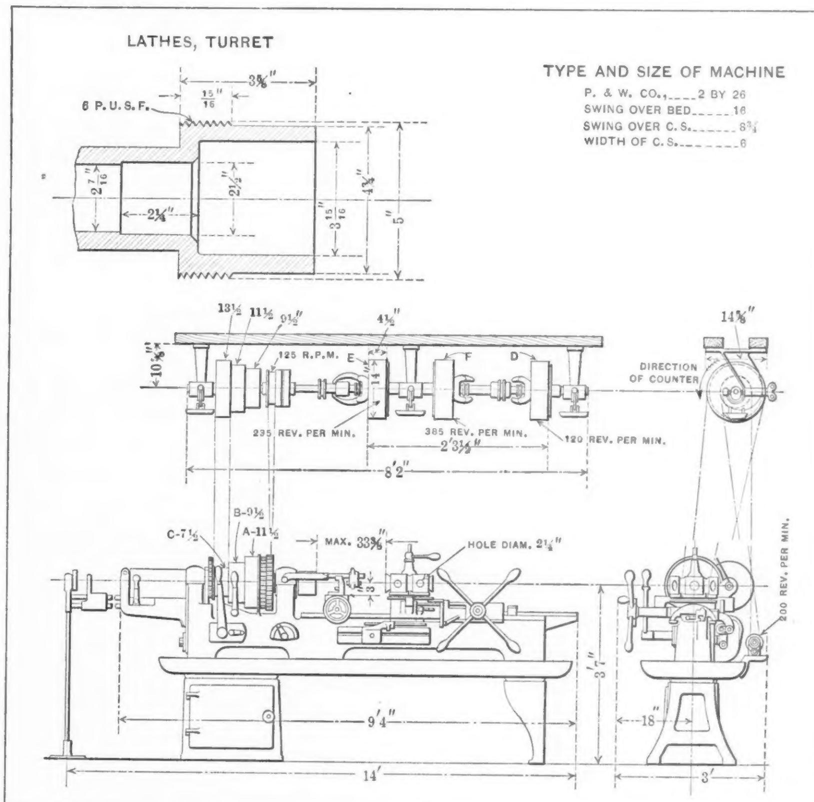


Fig. 1. Examples of Free-hand Sketches made by Tool Engineer to explain his Ideas to Tool Designers, illustrating Operation 6, Table I, and Operation 2, Table III



SPEEDS IN REVOLUTIONS PER MINUTE

	D			E			F		
	A	B	C	A	B	C	A	B	C
SLOW BACK GEARS	15	21	30	28	41	60	45	67	99
FAST BACK GEARS	44	56	83	75	111	164	124	183	269
OPEN BELT	114	145	213	194	285	423	319	466	692

FEEDS IN INCH PER REVOLUTION

	TURRET-SLIDE				CROSS-SLIDE			
FEEDS	0.007	0.011	0.015	0.020	0.0012	0.002	0.0028	0.0035

Machinery

Fig. 2. Sheet from Tool Engineer's Loose-leaf File of Machine Tool Equipment, giving Available Speeds and Feeds on Machines and Important Dimensions affecting Design of Tools and Fixtures

TABLE II. SPEEDS AND FEEDS FOR ROUGHING AND FINISHING CUTS

Material	Roughing Cuts		Finishing Cuts	
	Surface Speed, Feet per Minute	Feed, Inch per Revolution	Surface Speed, Feet per Minute	Feed, Inch per Revolution
Aluminum, Commercial	600	0.030	600	0.040
	400	0.040	...	0.030
	300	0.040	...	0.020
Brass, Composition	150	0.030	200	0.030
	120	0.040	...	0.020
	100	0.040	...	0.015
Brass, Yellow	250	0.030	300	0.040
	200	0.040	...	0.030
	150	0.040	...	0.020
Bronze	100	0.030	150	0.030
	70	0.040	...	0.020
	40	0.040	...	0.015
Castings, Gray Iron	60	0.040	80	0.500
	50	0.062	...	0.250
	40	0.125	...	0.125
Castings, Machine Steel	70	0.020	100	0.040
	60	0.025	...	0.030
	50	0.030	...	0.020
Castings, Malleable Iron	80	0.040	120	0.062
	60	0.050	...	0.040
	40	0.062	...	0.030
Forgings, Alloy Steel	60	0.015	75	0.020
	50	0.020	...	0.015
	30	0.025	...	0.012
Forgings, Machine Steel	70	0.020	100	0.025
	60	0.025	...	0.020
	50	0.030	...	0.015
Forgings, Tool Steel	50	0.012	70	0.020
	40	0.020	...	0.015
	35	0.030	...	0.012
Steel, cold-drawn or Rolled	100	0.030	150	0.025
	75	0.040	...	0.020
	60	0.050	...	0.015
Steel, Machine	70	0.020	100	0.025
	60	0.025	...	0.020
	50	0.030	...	0.015

Machinery

After planning the order of operations and deciding upon the type of machine on which each operation is to be performed, the tool engineer is ready to take up the design of jigs and fixtures. When he has decided upon the best method to follow in performing each machining operation, he calls in draftsmen from the tool designing department and explains the general requirements for each tool. The tool designers are experienced men, and much of the detail work is left to their judgment. For instance, the tool engineer will not specify the form of clamping mechanism to employ in each case, as he knows that his assistants in the tool designing department are thoroughly competent to handle this part of the work. But in many cases, where the method of machining is somewhat complicated and the tool engineer feels that there is a possibility of misunderstanding his instructions, he will make a free-hand sketch while he is explaining his ideas to the tool designer. This sketch is taken back to the drafting-room and constitutes the best possible form of memorandum for the designer in carrying out the instructions of the tool engineer.

Application of Free-hand Sketches in Tool Engineering

In connection with the work of the tool engineer, the ability to make good free-hand sketches rapidly is a valuable asset, as previously stated. Much time that would otherwise be required to explain his ideas can be saved by a judicious use of free-hand sketches. These can go into more or less detail, according to the complexity of the idea; but they should always clearly show the principle involved, so that the designer will not be obliged to come to the tool engineer with too many questions. The sketches reproduced in Fig. 1 give suggestions for handling Operation 6, Table I, and Operation 2, Table III, and are excellent examples of the way in which information can be conveyed by free-hand sketches. It will be noticed that all important points are shown on the sketches, so that the tool designer will not be compelled to do anything more than follow instructions.

The usual practice in designing tools for use in machining motor parts and similar work, would be to turn over to one tool designer the operation and tool list, and allow him to proceed with the designing of all tools for machining a particular piece, following the sequence of operations in their proper order. This is the ideal method, but it is subject to variation, depending somewhat upon numerous conditions, such as the number of jigs and fixtures required for machining the piece. When there are a large number of jigs and fixtures to be designed for any one piece, such as the cylinder block, it will be found advisable to have several designers working on the tools simultaneously in order to avoid delay. Another method which is sometimes used in large factories where a number of tool designers are employed is to divide the various men up into groups of three, four or six, and place each of these groups under the control of a capable designer who is also an experienced draftsman. An arrangement of this sort works out very nicely in practice, and relieves the tool engineer of the necessity of answering numerous questions in regard to points on which the tool designers want additional information. Such a group of draftsmen can be assigned to designing the tools for machining one piece for which a number of jigs or fixtures are required, and these men can work together and complete the designs very rapidly.

It is well to note at this point that a mistaken idea of economy exists in some factories in regard to the method of handling the work of tool designing. At certain seasons of the year, when a great number of new fixtures are to be made, a proportion of the drafting-room force is switched off to assist with the tool designing, although these men may or may not be adapted to the requirements of this particular class of work. A man may be a good designer of automobile parts and still be utterly incapable of giving satisfaction on tool design, because of lack of knowledge in regard to the most efficient methods of conducting machining operations and the conditions that must be fulfilled by jigs and fixtures. Such features as the provision of chip clearance, selection of the best locating points, and many other details which would be taken care of instinctively by an expert tool designer would puzzle the draftsman unfamiliar with this class of work, with the result that he is likely to neglect them. On this account it is advisable to secure the services of men on tool design who have had a number of years' experience in the shop, followed by the necessary drafting-room experience to make them proficient. It is poor economy for any concern to employ its regular drafting-room force for this purpose, unless it is well aware of the capabilities of certain of the men along these lines. In addition, the average designer on automobile work does not like to be shifted to tool design, as he prefers to specialize on his own particular line of work. However, this is a mistaken idea on the part of a designer, as he will find that the knowledge gained in tool design will be valuable to him in many ways in connection with other work.

Points to be Considered in Tool Designing

In making the tool drawings, the designer is governed entirely by the operation and tool list and the tool engineer's sketches, together with verbal instructions which he may have received in going over the matter with the tool engineer.

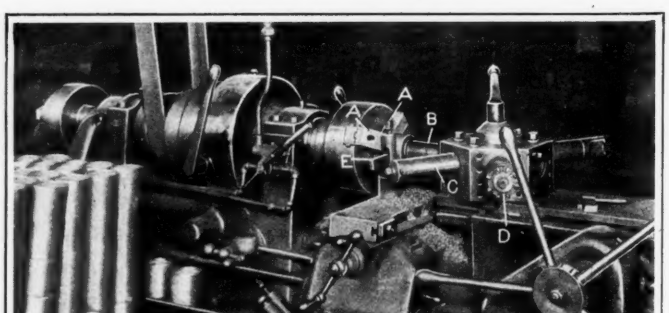


Fig. 3. Bardons & Oliver No. 7 Turret Lathe equipped with Hannifin Three-jaw Air Chuck and Tools for facing Open End of Pistons and boring and reaming Hole at End

In the first place, the design of each tool must provide for securing the required degree of accuracy in the work. When the number of parts to be produced is as great as that in the case under consideration, it is essential for every possible refinement to be incorporated in the design of the jig or fixture in order that there may be as little delay as possible in setting up and removing the work. For instance, the provision of quick-acting clamps may be the means of making a noteworthy reduction in the time occupied in setting up the work. The question of cleaning the fixture or jig should also be carefully studied and no deep pockets should be left in which chips will accumulate and cause trouble in obtaining correct locations. Whenever possible, the parts most subject to wear should be so designed that new parts can be quickly substituted when the old ones have worn beyond the required limits of accuracy, as the time lost in repairing tools is otherwise likely to be a serious matter. The provision of means for clamping the work and holding it in the correct position while being machined should also be very carefully studied; and all clamping devices should be both rapid and convenient to operate, as well as so designed that there will be no possibility of the piece being cramped or thrown out of its true position when clamping. Many of these points are considered, and methods suggested, at the time that the tool engineer outlines his ideas to the tool designer. In making up each drawing, the position of the work should be indicated by either a dotted or a red line, so that the purpose of each part of the jig or fixture will be evident to the toolmaker.

There are a number of important details in connection with the making of tool drawings which are taken care of in various ways, according to the system in vogue at the particular factory where the work is being done. To facilitate the work of toolmaking, it is essential to include on the completed drawing a bill of material, which gives the amount of stock required in making the jig or fixture, with the necessary allowance for finish. When this is done, the completed drawing goes to the ordering-in department, where the order is issued for the various materials needed in the construction of the tool. A still better way to handle this matter is to have the tool designer issue orders for the stock on regular stock cards, which are attached to the tool drawing by clips after the drawing has been completed, thus showing the tool-room foreman what stock is required for the job. Upon completion of the drawing, it goes to the tool engineer, who looks over the general points of construction and features of design, and makes any suggestions which he may deem advisable. After he has approved the drawing, it goes to the checker, who carefully goes over all dimensions to be sure that there are no errors when it is sent to the tool-room accompanied by an order to make the tool. Just exactly why this precaution is frequently omitted in connection with tool drawings it is hard to say, but the fact remains that many of them are allowed to go directly to the tool-room. It follows, therefore, that any errors which occur are either discovered by the toolmaker while doing his work or else they go through without discovery until the fixture is finally checked before it is sent into the shop. Even then, an error may not be discovered unless the work which has been machined in the fixture is inspected to see that it conforms to the requirements of the blueprint of the engine part. In cases where several jigs or fixtures are to be made for machining the same piece of work, it is especially important for the drawings to be carefully checked in order to see that no errors occur. In this particular instance, we shall assume that the drawings have been checked and O. K.'d by the tool engineer, after which they are ready to be sent to the tool-room.

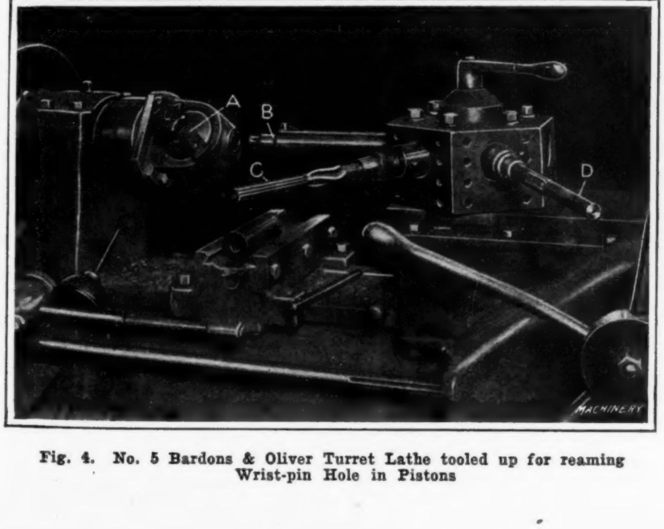


Fig. 4. No. 5 Bardons & Oliver Turret Lathe tooled up for reaming Wrist-pin Hole in Pistons

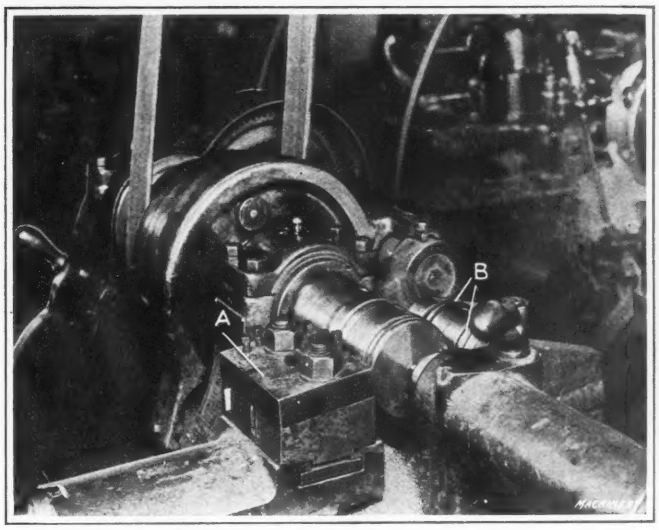


Fig. 5. Cincinnati Lathe & Tool Co.'s 16-inch Engine Lathe tooled up for turning and burnishing Ring Grooves in Pistons

Making Tool Drawings

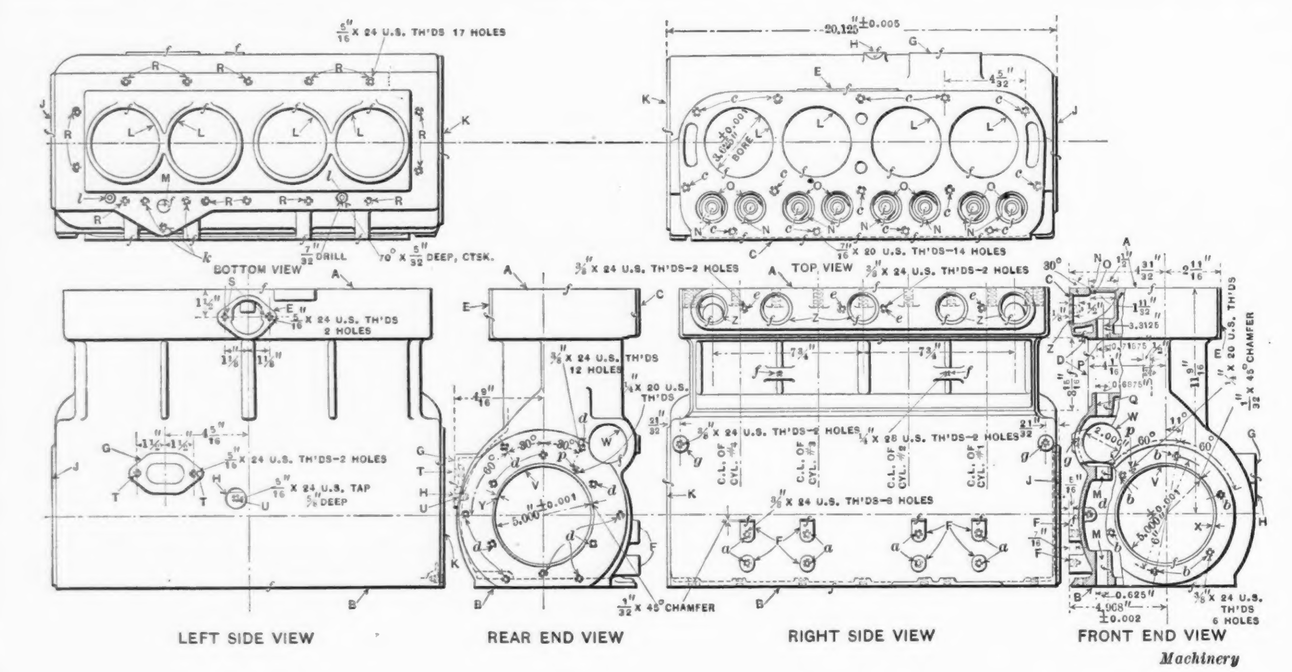
Several methods are employed by different factories in making their tool drawings. One of these is to make the drawings in lead pencil on manila paper, and send them out to the tool-room after they have been varnished and attached to a board. Another method is to use tracing cloth (not paper) on the rough side of which the tool drawing is carefully laid out in pencil. A No. 3 pencil gives very good results in printing and will not smudge appreciably. The objection may be raised that the use of tracing cloth for making tool drawings is too expensive; but it will be found that although the first cost is somewhat greater than when manila paper is used, the convenience and time-saving features will more than offset this difference in cost. It may also be said that a pencil drawing made on tracing cloth will be smudged and made illegible, or that the blueprints taken from such a drawing will not be sufficiently clear. But several of the large machine tool builders in this country are securing excellent results from this system at present, which should be sufficient to vouch for its practicability. The use of tracing paper is not to be commended on account of the wear and tear to which it may be subjected in handling.

There are a number of advantages secured through the use of tool drawings made on tracing cloth. One of these is that blueprints can be made which can be sent to the pattern shop and to the toolmaker, while additional copies can readily be made if, for any reason, other departments may require them. Another advantage is that in redesigning or making over a jig or fixture to meet the requirements of a new model or design, the pencil marks on the tracing can be easily rubbed off and the necessary changes made with very little labor. In addition to this, it may be desirable to keep a record of the original tool drawing, which can be easily done by making a blueprint and marking it "record print." This can be filed in its proper place and referred to at any time.

Use of Filing Systems and Care of Tool Drawings

An excellent system for filing tool drawings and lettering them so they can be easily found is to standardize the various sizes of sheets; for example, 9 by 12, 12 by 18, 18 by 24, 24 by 36 inches, etc. Each of these sizes is designated by a letter, as "A" for the 9 by 12 size, "B" for the 12 by 18 size, etc. It is also advisable to have one letter to designate extra sizes

TABLE III. MACHINING OPERATIONS ON CYLINDER BLOCK—MATERIAL, CAST IRON



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Pickle to remove sand and scale	Lead lined baths	....	....	..	..
2	Mill top and bottom surfaces A and B, valve port faces C and valve dust plate seat D	20 by 20 inch by 18 foot planer type milling machine	Special fixture; holds eight blocks. Inserted-tooth cutters. Setting up gages	Crankshaft bearing holes and valve chamber	15	2
3	Drill and ream two dowel-pin holes in base (not shown)	Two-spindle 16-inch vertical drilling machine	Drill jig with slip bushings. Quick-change chucks	Milled top surface A and valve dust plate seat D	22	1
4	Mill pad E for water intake pipe	No. 1½ horizontal milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
5	Rough-mill seat F for magneto bracket, breather pipe boss G and oil dial boss H	No. 2 horizontal duplex milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
6	Finish-mill seat F for magneto bracket, breather pipe boss G and oil dial boss H	No. 2 horizontal duplex milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
7	Rough-face ends J and K of cylinder block	20 by 20 inch by 18 foot planer type milling machine	Special fixture; holds ten pieces. Inserted-tooth milling cutters	Dowel holes	20	1
8	First rough-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	20	1
9	Second rough-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	22	1
10	Drill, ream and plug cored holes (not shown) at each end of valve chamber	Two-spindle 25-inch vertical drilling machine	Angle-plate fixture with locating pins and clamps	Dowel holes	20	1
11	Finish-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	22	1
12	Inspect cylinders for finish and diameter	....	Limit gages	....	..	..
13	Drill and ream pump shaft holes M	26-inch vertical drilling machine	Quick-change chucks. Drill jig	Dowel holes	24	1
14	Inspect alignment of pump shaft holes M	....	Gages	....	..	..
15	Bore and face valve seats N and holes O, drill and ream valve stem and push-rod guide bushing holes P and Q, respectively	Eight-spindle vertical drilling machine	Drill jigs and jig plates	Dowel holes	24	4
16	Hand-ream valve stem and push-rod holes P and Q, and test alignment	....	Special reamers. Limit gages	....	5-6	4 men
17	Test water jacket under 60 pounds water pressure per square inch	Special machine	Pressure gages	....	20	1
18	Drill fourteen bolt holes R in base	Sixteen-spindle drilling machine	Special jig plate and fixture	Dowel holes	22	1
19	Drill two holes S in water intake pad, two holes T in breather pipe pad and one hole U in oil dial boss	Eight-spindle drilling machine	Special fixture and jig plate	Dowel holes	25	1
20	Rough-bore hole V for crankshaft bearing and hole W for cam-shaft bearing	Duplex No. 5 boring machine	Fixture	Dowel holes	20	1
21	Finish-bore for crankshaft bearing V and cam-shaft bearing W, face off bearing bosses J and K, and chamfer crankshaft bearing hole at X and Y	Duplex No. 5 boring machine	Combination boring and facing tools	Dowel holes	15	2
22	Hand-ream cam-shaft bearing hole W	Bench	Fixture and special reamers	....	25	1
23	Counterbore ports Z for intake and exhaust manifolds	Five-spindle vertical drilling machine	Special five-spindle drill head jig	Cam-shaft bearing holes, cylinders and faced side of casting	25	1
24	Complete facing ends of cylinder not done in Operation 21	26-inch engine lathe	Faceplate fixture. Raising blocks	Crankshaft bearing holes V	20	1
25	Drill forty-eight holes a, b, c, d, e, f and g in the cylinder block casting from four sides	Special multiple-spindle drilling machine	Work-holding fixture	Dowel holes	30	1

TABLE III. MACHINING OPERATIONS ON CYLINDER BLOCK—CONTINUED

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
26	Tap five holes T, S and U in breather pipe, water intake and oil gage bosses, and spot-face cam-shaft bearing lock-screw holes g	3-foot radial drilling machine	Tapping attachment	Crankshaft bearing holes V	15	2
27	Drill three holes k for holding oil pump and two holes l for holding distributor pipe. Spot-face two holes l	22-inch vertical drilling machine	Quick-change chucks. Plate jig	Top A of cylinder block	20	1
28	Tap fourteen holes a in magneto pads, e in manifold seats, and g in cam-shaft bearing lock-screw bosses	No. 2 automatic tapping machine	....	Crankshaft bearing holes V	15	2
29	Tap twelve holes d in rear end and six holes b in front end of cylinder block	No. 2 automatic tapping machine	....	Ends of cylinder blocks	12	2
30	Tap fourteen holes c in top and seventeen holes R and k in bottom	No. 2 automatic tapping machine	Quick-change chucks	Top and bottom of cylinder block	20	2
31	Drill and tap two holes p for oil distributor tube clip. Hand-tap two holes f for valve dust plate	Sensitive drilling machine with tapping attachment	Quick-change chucks	Finished surfaces on cylinder block	12	2
32	Press eight valve stem guides P into place	No. 5 arbor press	....	....	25	1
33	Hand-ream guide holes P and burr edges and top	Bench	Reamers	....	20	1
34	Hand-seat valves at N	Bench	Piloted valve seating tools	....	20	1
35	Grind in valves	Eight-spindle valve grinder	....	....	12	2
36	Inspect valve seating	Bench	....	....	..	..
37	Wash in hot soda solution to remove grease	Soda kettle	....	....	..	..
38	Assemble valves in cylinder blocks	Arbor press	Fixture to hold down eight valves at a time when inserting locking pins	....	..	..
39	Final inspection	....	Gages and indicators	....	..	..

which may be necessary in the design of a special machine or an exceptionally large fixture. "X" answers very well for this purpose, and a separate filing drawer should be used for these odd-sized drawings. It is a good idea to put the letter and the accompanying number of the drawing in the lower left-hand corner and again in the upper right-hand corner upside down, so that no matter which way the drawing happens to be placed in the drawer, the number will always be easily seen. A drawing record book should be prepared, containing consecutive numbers under each size and letter; and these numbers should be checked off as they are used. A card file system should also be devised, the cards being arranged numerically by piece-number or alphabetically by the name of the piece, according to the system in vogue in the factory, and the numbers of the drawings which apply to the tools and fixtures on any piece can then be entered on these cards. In this way, a double file is available so that any required tool drawings can be located from their tool drawing numbers or from the name or piece-number of the part on which they are used.

List of Machine Tool Equipment

In the tool engineering and tool design department, a complete list of the machine tool equipment of the factory will be found useful. The requirements will vary according to the machine tool equipment in the factory; but in any case the list should be as complete as possible, and should include the capacity of all machines. In many factories, the tool designer, when at work upon a fixture or jig, is obliged to go out into the factory and measure up the machine on which the fixture is to be used. This is entirely unnecessary when a reference list is kept in the tool engineer's office, as such a list may easily be made to contain all the necessary information for any of the machines in the shop. This list of machine tool equipment may be conveniently kept in a card file; Fig. 2 shows one of the cards from such a file, which gives the dimensions of a horizontal turret lathe. Reference to this illustration will show that the form is so arranged as to give the necessary data on all machines of this type, together with the available feeds, speeds, and general features of construction. There are few ideas which can be applied to tool designing that are capable of saving more time than this system of recording the mechanical equipment of the factory. It requires a certain amount of time and care to compile such a list, and a little work is necessary from time to time to keep it up to date, but the expense involved will be more than offset by the time saved. In the preparation of an index of this kind, outline drawings of different types of machines can usually be found in machine tool builders' catalogues. These outline drawings can be cut out and pasted on a good sized card, say 8 by 10 inches, so that they can be handled without difficulty. If desired, the reference index can be extended to include much other data of value to the tool engineer. This data may take the form of trade journal clippings referring to new developments in machine tools, special tools which have been designed for work similar to that done in the factory, and much other valuable data.

In order to explain the practice followed in determining the best order in

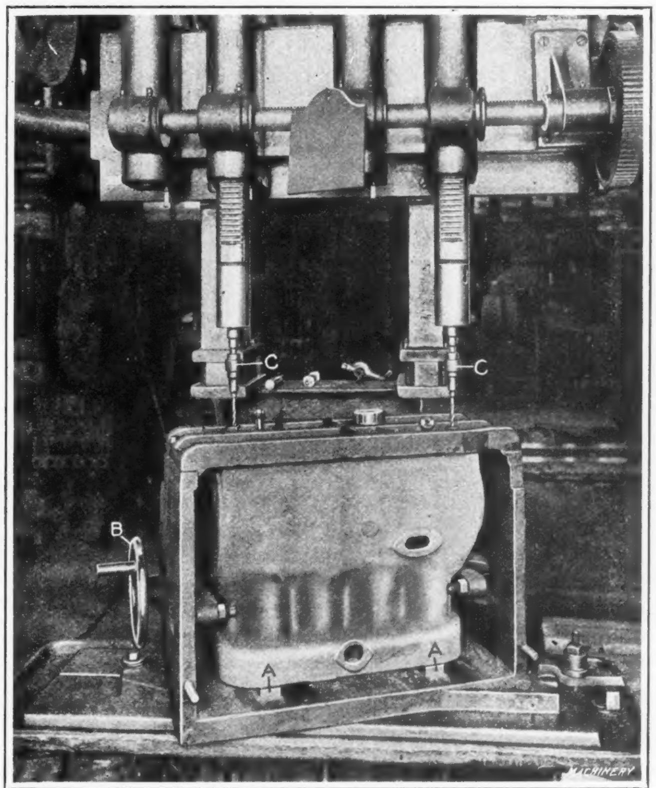


Fig. 6. Two-spindle Foote-Burt Drill Press equipped with Quick-change Chucks and Tools for drilling and reaming Master Locating Holes in Base of Cylinder Blocks

which to perform machining operations, deciding the type of machine to use in each case, and selecting points from which to locate the piece for each operation, examples have been selected for each of the motor parts under consideration, and these will be discussed in detail. The accompanying illustrations show the machines tooled up, with the work in place in the fixtures; and these equipments will be referred to in explaining the conditions which determined the design of the tools along these particular lines.* Using the operation and tool lists on which the sequence of operations has been set down, the tool engineer proceeds to make a study of points which govern the method of performing the machining operations. The selection of suitable locating points for the first machining operation on any piece is of exceptional importance, because it determines to a large extent the accuracy which will be obtained in the finished work. For this reason the greatest care must be exercised in looking after this part of the work. In all cases the locating points should be so selected that there will be little likelihood of any ordinary variations or defects in the castings or forgings preventing the work from being properly located in the jig or fixture.

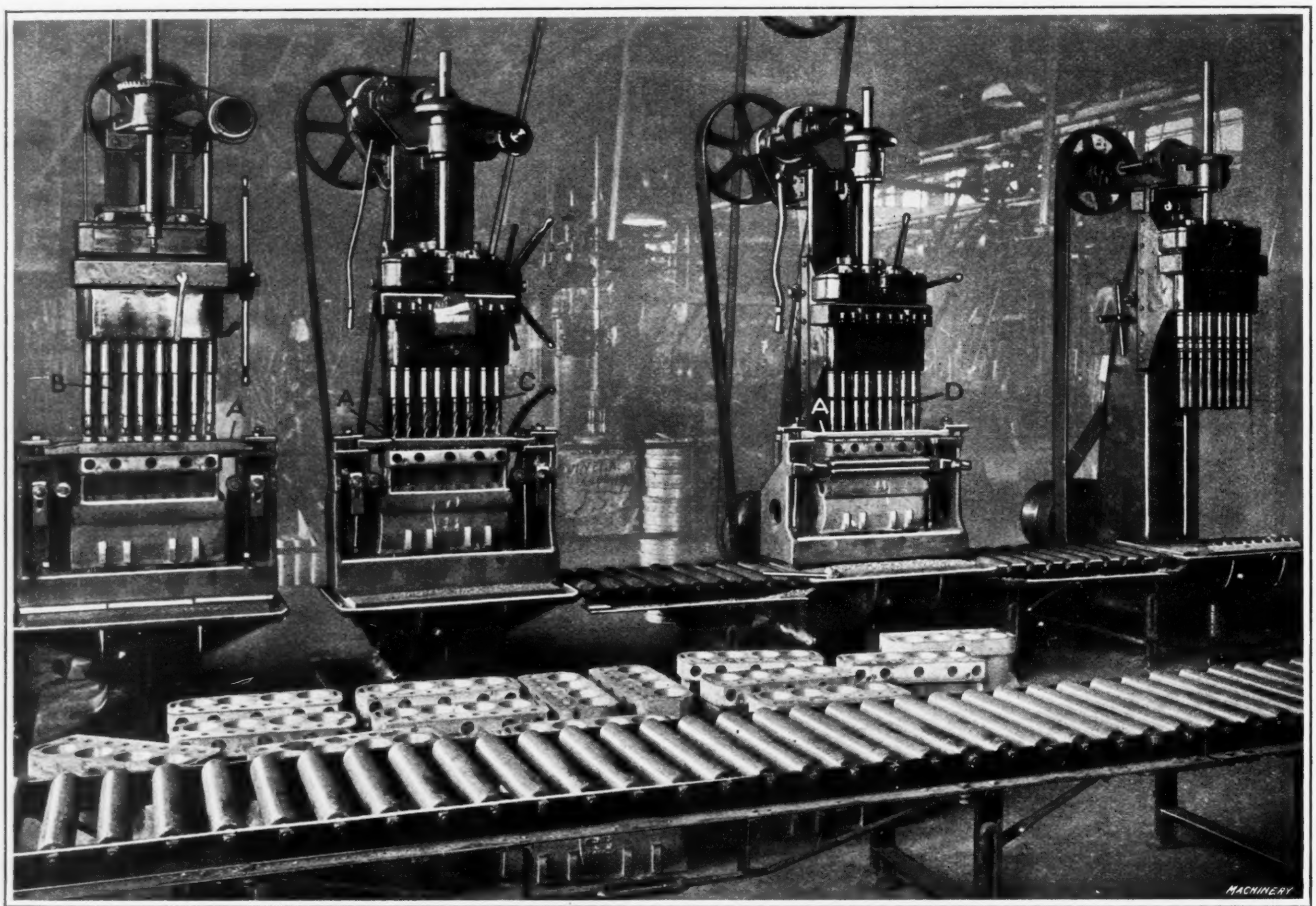


Fig. 7. Foote-Burt Eight-spindle Drill Presses equipped with Fixtures having Interchangeable Jig Plates for boring Valve Port Holes, and drilling and reaming Holes for Valve-stem and Push-rod Guide Bushings in Cylinder Blocks—Note Conveyor System provided to facilitate handling Work

Estimating Production on Machining Operations

In estimating production on any machining operation, the first points to receive consideration are the type of machine on which the work is to be done, the nature of the tools and fixtures with which this machine is equipped, and the material to be machined. In connection with this work, a comprehensive knowledge of the proper cutting speeds and feeds to use when working on different classes of metal is absolutely essential. A competent tool engineer will have gained this knowledge from experience; but for the benefit of those readers of MACHINERY who are less familiar with work of this kind, Table II has been arranged to show the cutting speeds and feeds to use on various classes of metal met with in manufacturing work. These figures are based upon the use of high-speed steel cutting tools, and the amount of stock removed is assumed to be normal, *i. e.*, from 3/32 to 1/8 inch on a side for the roughing cut and from 0.010 to 0.015 inch on the diameter of the work for the finishing cut. It will be seen that three sets of figures are given in each case for the roughing cut. The upper figures represent the maximum cutting speed and corresponding rate of feed, which should only be used under the most favorable conditions; the next set of figures represents a high cutting speed which can be used except when the metal is exceptionally tough or hard; the lower figures are decidedly conservative and should only be used for estimating purposes when the greatest care is required in machining. For the finishing operation, one cutting speed is given in each case, but three rates of feed are presented, which can be used with the given speed according to the conditions of operation.

In using a table of this kind, it will be well to remember that no tabular matter can be safely accepted as an absolute guide for the cutting speed and feed which can be used on any class of work. In the present case, however, Table II may safely be used as a basis on which to form a fairly accurate estimate of production for all normal classes of work. In practice, it is frequently found that after work has been started in the shop, it is possible to increase production somewhat because the high quality of the material enables a higher cutting speed and feed to be used than those used in the tool engineer's estimate. Conversely, it sometimes happens that the material is of poor quality, and this will naturally result in reducing production below the figure estimated. In compiling Table II, it was assumed that all material except cast iron and yellow brass is provided with a suitable cutting lubricant while machining. In cutting aluminum, some factories follow the practice of working the material dry, while in other factories, a lubricant is used which is composed of equal parts of lard oil and kerosene. It would appear that the use of such a lubricant should be the means of securing a

* The machines shown are in use in the Detroit factory of the Maxwell Motor Co., Inc., and we are indebted to this firm for the privilege of making a study of its methods of manufacture, upon which is based much of the information concerning the order in which operations are performed and the methods of machining that are outlined in the operation and tool lists presented in this article.—Editor.

higher finish, and that it would also enable a higher rate of production to be obtained; but in one well-known factory, aluminum is being worked dry at a cutting speed of 600 feet per minute, and very satisfactory results are obtained.

In estimating the amount of time which should be allowed for setting up the work in the fixture, indexing turret machines, changing tools, etc., and removing the finished work, a number of matters must be taken into consideration, and the accuracy of the result will be largely dependent on the judgment of the estimator, which, in turn, is the result of his experience in doing work of this kind. In deciding upon the amount of time required for going through the different movements necessary in the performance of a machining operation, the estimator will often be able to secure accurate information by timing himself with a stop watch while going through a series of "false" motions just as if he were actually doing the work himself. This may appear somewhat foolish to the uninitiated, but it is necessary in many cases for the most experienced estimators to adopt this method in order to reach an accurate conclusion concerning the time required for unusual classes of work. In order to determine the number of revolutions per minute at which the cutter or work should revolve to produce a given cutting speed expressed in feet per minute, the tables presented in MACHINERY'S HANDBOOK on pages 800 and 801 will be found convenient.

The formula for calculating the cutting speed in revolutions per minute at which a piece of work should run can be evolved from the following:

$$\frac{\pi D N}{12} = \text{cutting speed in feet per minute}$$

where D = diameter in inches;
N = revolutions per minute.

This formula can be reduced to the following form:

$$0.262\, D N = \text{cutting speed in feet per minute.}$$

It will be noticed that the constant 0.262 is very close to 0.250, which would be ¼; hence the following formula can be evolved:

$$N = \frac{4C}{D} \qquad (1)$$

where D = diameter of work, in inches;
N = number of revolutions per minute;
C = cutting speed, in feet per minute.

This formula is accurate within about 5 per cent, and will be found useful for making rapid calculations in estimating.

In order to show the application of the formula, let us assume that a piece of cast iron 8 inches in diameter is to be machined and that the tool engineer has assumed a permissible cutting speed of 50 feet per minute on the work. He wishes to know the number of revolutions per minute at which the work must revolve in order to give this cutting speed. Then, applying the formula with $D = 8$ and $C = 50$, we have:

$$N = \frac{4 \times 50}{8} = 25 \text{ revolutions per minute.}$$

In the factory, when it is desired to determine the cutting speed at which a piece of work is being machined, the formula can be transposed to give the cutting speed C in feet per minute. In this case the formula would be as follows:

$$\frac{DN}{4} = C \qquad (2)$$

Let it be supposed that a piece of work 8 inches in diameter is revolving at 25 revolutions per minute, and that it is desired to know the cutting speed C at which the work is being machined. Substituting in Formula (2), we have:

$$\frac{8 \times 25}{4} = 50 \text{ feet per minute} = \text{cutting speed.}$$

In addition to determining the cutting speed, number of revolutions, etc., on a piece of work, the tool designer must also take advantage of short-cuts to facilitate calculations for determining the time necessary to take a specified length of cut at a given cutting speed. The following formula will be useful for that purpose. To determine the amount of time necessary to take a cut at a given speed and feed, let:

N = speed in revolutions per minute;
F = feed in inches per revolution;
L = length of cut in inches;
T = time in minutes to complete cut.

$$T = \frac{L}{NF} \qquad (3)$$

To explain the use of Formula (3), let it be supposed that a piece of work to be machined has a diameter D of 8 inches, that the speed N is 50 revolutions per minute, that the feed F is 0.025 inch per revolution, and that the length of travel L in taking the cut is 4 inches. Substituting these values, we find the length of time T required to make the cut is:

$$T = \frac{L}{NF} = \frac{4}{50 \times 0.025} = 3.2 \text{ minutes} = 3 \text{ minutes and 12 seconds.}$$

In a great many cases, the tool engineer makes many of these calculations mentally in estimating production, although the processes through which he arrives at the conclusions are based on the foregoing formulas. Experience is an important factor in estimating the length of time necessary to do any

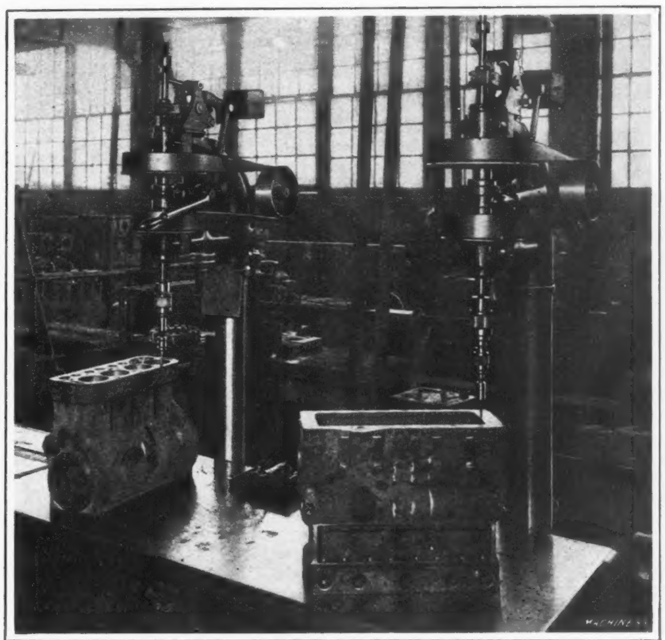


Fig. 9. Garvin No. 2 Automatic Tapping Machines equipped with a Single Table to facilitate handling Work in tapping Fourteen Holes in Top and Seventeen Holes in Bottom of Cylinder Blocks

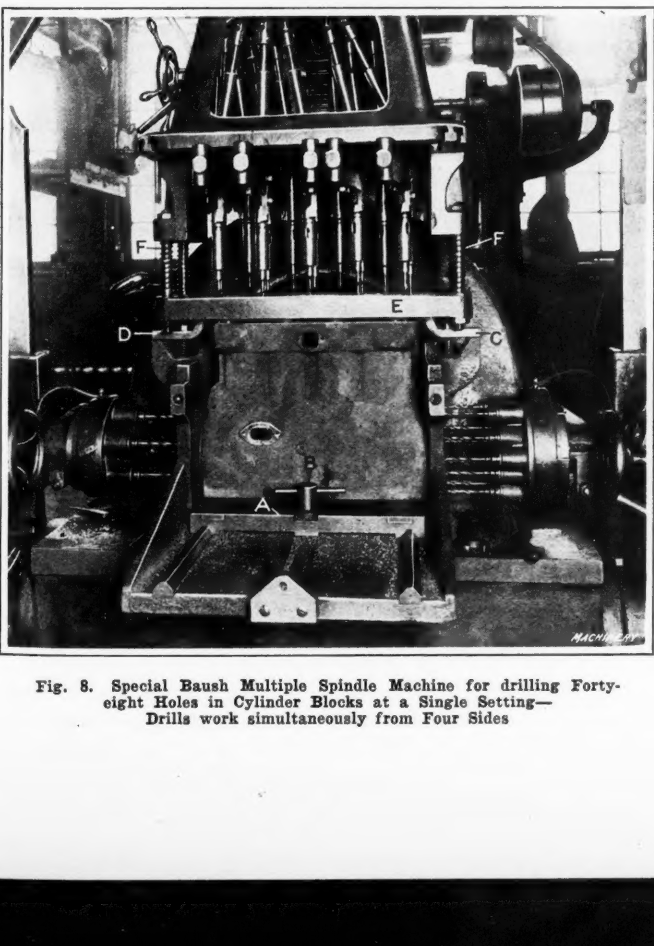


Fig. 8. Special Baush Multiple Spindle Machine for drilling Forty-eight Holes in Cylinder Blocks at a Single Setting—Drills work simultaneously from Four Sides

piece of work for the reason that so many factors enter into the problem and so many small items have to be considered in addition to the actual amount of time necessary to make the cut.

Incidental Matters Pertaining to Estimating

It is fully as important in estimating production on a given piece of work to take into consideration the various movements involved in operating the machine, setting up the work and changing the tools, as it is to figure the length of time which the machine will actually take in doing the cutting. Some of these points are given consideration in connection with a brief discussion of the performance of machining operations on different types of machines such as turret lathes, vertical boring mills, milling machines and drilling machines. Some of the general points which apply to all classes of machines are as follows:

1. Conservative Estimate of Capacity.—The tool engineer's estimate should always err on the conservative side, as it is better to find that a little more than the required production is produced by a given equipment than that the output is too low. This point, however, must be carefully looked into when too conservative an estimate would involve the purchasing of a new machine tool or group of tools.

2. Setting up Work.—In taking into consideration the time required for setting up the work in a jig or fixture, or on a machine, attention must be paid to the care with which it is necessary to locate the piece in the fixture, the complexity of the clamping devices that have to be operated, and the method of setting up the work. The difficulty of placing the piece in position, owing to its general character and shape, must also be carefully considered in this connection.

3. Removing Work from Fixture.—It is always easier to remove a piece of work from a fixture than it is to set it in place and tighten the clamps; but the fixture often has to be cleaned before it can be used for holding another piece of work. In the case of small fixtures, jigs, etc., which are removed from the table of the machine during use, and which are used on cast-iron work where no lubricant is applied to the cutting tool, the fixture may be occasionally dipped in a soda kettle to clean it out, or an air blast may be used to blow away the dry chips. When the fixtures are used in connection with a cutting lubricant, the lubricant itself can be used to wash out any chips which may have accumulated in places where they are likely to cause trouble. However, this point should always be considered in the design of tools, and taken care of as far as possible by making the tools of such shape that chips will not accumulate.

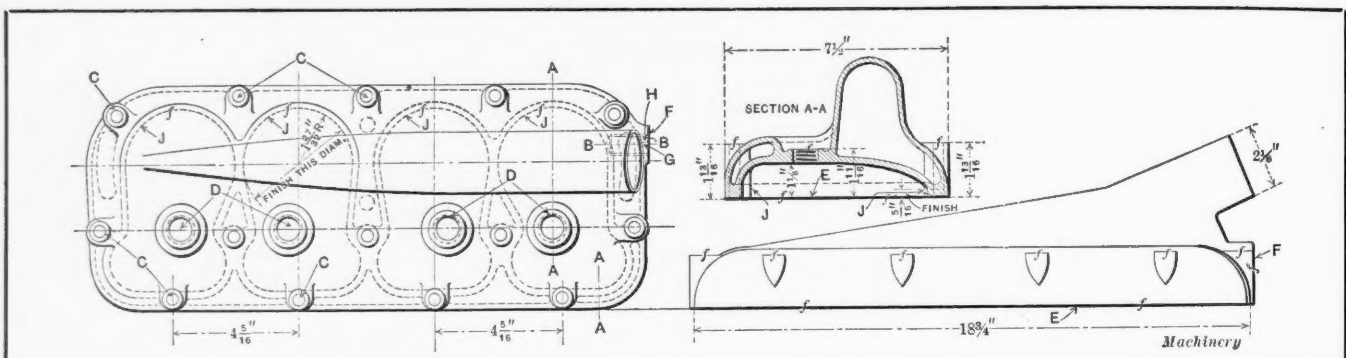
4. Weight of Work.—When the work is small, the weight need not be considered, so long as a man can lift it easily and place it in position without assistance. If, on the other hand, the work is of considerable size and weight, requiring the assistance of a helper in setting it in position, the weight must be taken into consideration in estimating production, because it affects the length of time necessary to handle the piece.

5. Size or Depth of Cut.—This point must always be taken into consideration, as it affects both the feed and the speed that may be employed.

6. Idle Movements of Machine.—In estimating production on any operation in which the machine movements are numerous, these must be taken into consideration and a liberal allowance made to take care of this part of the work. For instance, time must be allowed for the approach of the spindle to the work in a drilling machine and for its withdrawal after the work has been done, as well as the excess movement beyond the actual cut.

7. Setting and Removing Tools.—In certain classes of work, the resetting of sharpened tools and the removing of dull tools for grinding should be taken into consideration, if a close estimate of production is desired. Much depends, however, upon the class of work which is being done and the number of tools included in the equipment. In some cases, a moment's time might be all that would be necessary to make the replacement, while in others, when a large equipment of tools is used, some minutes might be consumed in resetting. In the modern factory, the tool equipment should always be built in duplicate, so far as the actual cutting tools are concerned,

TABLE IV. MACHINING OPERATIONS ON CYLINDER HEAD—MATERIAL, CAST IRON



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Face-mill fourteen bosses C for hold-down bolts	No. 13 P. & W. single-spindle profiling machine	Simple clamping fixture	Cored combustion chambers in head	20	1
2	Drill holes D for four spark plugs	28-inch vertical drilling machine	Four-spindle drill head. Drill jig	Finished bosses C	60	1
3	Face under side E of head	No. 3 vertical milling machine	Milling fixture	Finished bosses C	15	2
4	Spot-face four holes D for spark plugs	23-inch vertical drilling machine	No fixture used. Fly-cutter with pilot	Fly-cutter pilots in spark plug holes	75	1
5	Drill fourteen holes C from under side	Sixteen-spindle drilling machine	Jig plate	Three locating pads on casting	25	1
6	Mill off face of fan stud boss F	No. 2-B horizontal milling machine	Clamping fixture	Drilled holes in cylinder head	50	1
7	Drill dowel-pin hole G in fan support boss F	11-inch speed lathe	Special holding fixture	Drilled holes in cylinder head	60	1
8	Drill and tap hole H in fan stud boss F	21-inch vertical drilling machine	Tapping attachment. Quick-change chucks	Drilled holes in cylinder head	25	1
9	Counterbore combustion chamber holes J	24-inch drilling machine	Four-spindle drill head	Drilled holes in cylinder head	30	1
10	Tap four holes D for spark plugs	21-inch vertical drilling machine	Tapping chuck. No jig	Set up on milled surface	30	1
11	Wash in oakite	Soda kettle	....	....	..	1
12	Water test at pressure of 60 pounds per square inch	Special testing machine	....	....	..	1
13	Final inspection	....	Gages	....	..	..

so that the minimum amount of time will be lost in replacement or renewal of tools.

8. Setting-up Time.—This refers to the setting up of the machine itself for doing the work, and is not ordinarily considered unless the complete time of the machine is not used on one operation and it needs to be set up with different equipments a number of times a day. In cases of this kind, it is necessary to take the matter of resetting tools into consideration when making an estimate. When it is necessary to estimate this time, it should be considered as a total amount and distributed over a lot of pieces in about the proportion that each would consume.

Turret Lathe and Boring Mill

1. Indexing Turret.—The time occupied in indexing the turret must be taken into consideration in estimating production on work which is machined in a turret lathe. The time required for running back the turret should also be considered. In estimating this time on hand-operated machines, the best way is for the tool engineer to take some actual examples in the factory and note down results, always taking into consideration the length of the tools used and the distance which they must be withdrawn before the turret is indexed. In one case it might be found that a six-sided turret could be indexed to all its faces in 15 seconds with a certain equipment of tools, while in another case 25 or 30 seconds might be necessary on account of the long distance to be traveled before the index dog is tripped. In the case of a boring mill, the time required for the travel of the head must be allowed for in connection with the other points; and if the machine is of the type that has a turret head, the time occupied in indexing this turret must also be taken into consideration.

2. Actual Speed of Machine.—It is easy enough to make an estimate of the time required for a certain cut at a specified speed on a turret lathe or boring mill, and yet it may be found that the required speed cannot be obtained on the machine itself without providing a special drive which naturally would not be done unless production could be increased to a considerable extent, or unless the machine were to be used on one particular job constantly. Hence, the tool engineer, in deciding the cutting speed at which a turret lathe is to run, must at the same time refer to his table of machine tool equipment and select the nearest actual speed at which the machine can be run, and then use this speed in figuring in place of the one called for by the cutting speed desired.

3. Incidentals.—Among the incidentals which must be taken into consideration on this kind of estimating are such things as the "dwell" allowed at the end of a counterboring cut to smooth up the surface and obtain the exact depth desired; the changing of speed when it involves something more than the mere movement of a lever; and the changing of tools, as previously mentioned. Some other points may be taken into consideration on certain classes of machines, but those mentioned are the most important.

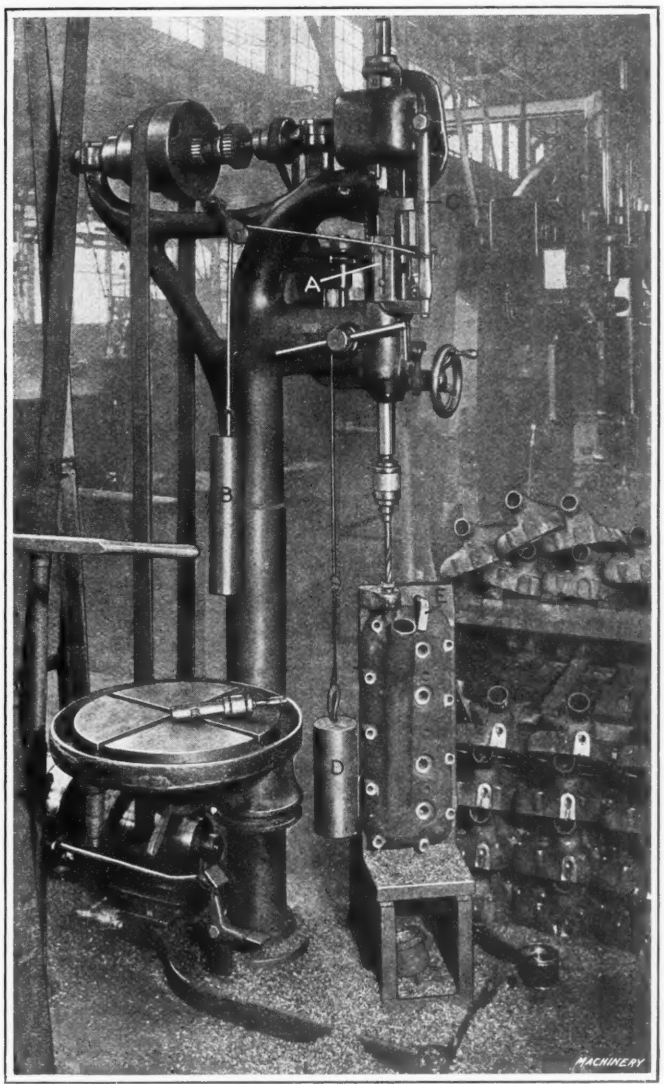


Fig. 10. Reed-Prentice 21-inch Drill Press tooled up for drilling and tapping Hole in Fan Stud Boss on Cylinder Heads—Note Special Reversing Mechanism for backing out Tap, and Wiard Quick-change Chuck

Milling Machines

1. Supports for Work.—The kind of support with which the work is provided must always have an effect on the estimation of milling machine production. In the design of fixtures for use on this class of machine it is always advisable to make the supporting point as rigid as possible, and thus avoid the possibility of chatter. There are some cases, however, when the nature of the work is such that it is difficult to support it properly. If the work is thin, the cuts and speeds, together with the feeds, must be less than if the casting is of a heavy section.

2. Finish Desired.—The quality of finish necessary on a piece which is to be milled makes considerable difference in the speeds and feeds that can be used, and must be considered in making an estimate of production.

3. Diameter of Cutters.—The diameter of cutters must be taken into consideration for the reason that the feed is, to a certain extent, dependent upon it.

Drilling Machines

Accuracy Required.—This point must be considered in estimating production on drilling operations; and in this connection, the feeds and speeds used must be carefully considered. High-speed drilling, with coarse feeds, cannot be made to produce extremely accurate results with ordinary twist drills, and the nature of the work must always be considered in this connection. It is well to remember that in order to obtain accurate results on drilled work, the speeds should be somewhat higher and the feeds rather fine.

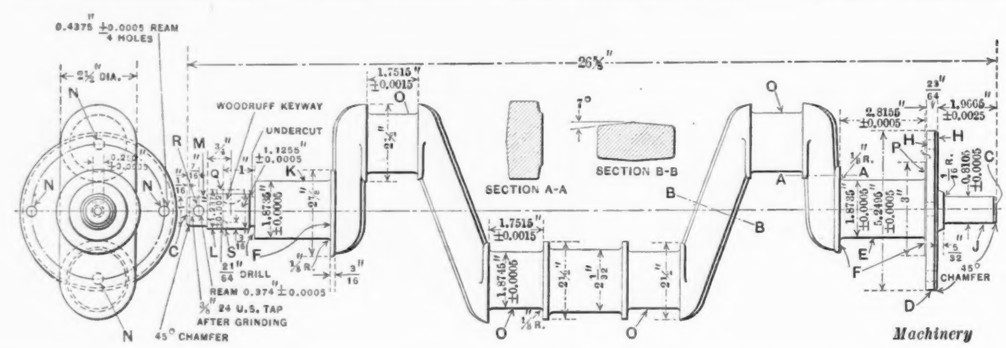
Machining Operations on the Piston

The manner of locating the piston for the first operation is of exceptional importance, because it is made with an internal cored opening which is likely to vary somewhat in its relation to the exterior surface, so that the two surfaces will not be concentric in the rough casting. Naturally, it is important for the piston castings to be machined in such a way that the interior and exterior surfaces will be approximately concentric when the work is finished. If a method of holding from the outside were used in the preliminary machining operation, there would be a probability of the casting having walls of variable thickness, the pistons would not all be of equal weight, and therefore the motor in which such pistons were used would be more or less out of balance unless a method of counteracting this defect were employed. If the piston were located from the outside, there would also be a possibility of the cutting tools for the ring grooves breaking through the walls, if the casting happened to be very eccentric; or if the groove cutting tools did not actually break through the wall, they might at least run dangerously close and leave a thin section which would be unsafe. Taking these points into consideration, the tool engineer decides that the best plan will be to hold the

work by the inner cored surface for the first operation, in order to be sure of producing pistons of uniform weight and thickness of wall.

Having decided upon the locating points for the first operation and all subsequent operations, the tool engineer now decides the best type of machine on which to do the work in each case, the form of holding device to employ, and the tools to use for each machining operation, after which he is ready to calculate the production that will be obtained. For instance, in the operation and tool list for the piston presented in Table I, Operation 3 consists of facing the open end *C* and boring and reaming hole *D*. In deciding upon the locating points for this operation, the tool engineer considers the fact that he has previously held the work by the inside and has roughly machined the exterior surface so that it is approximately concentric with the interior. Therefore it is logical to hold the work for this operation by the machined exterior surface, using a three-jaw chuck with a set of soft jaws *A*, as indicated in Fig. 3. The soft jaws will be bored out to the size of the outside of the piston when the chuck is in place on the machine. Owing to the fact that several tools must be used in performing Operation 3, the selection of a turret lathe seems advisable because the necessary tools can be quickly presented in sequence. The use of roughing and finishing boring-bars, *B* and *C*, and a finishing reamer *D* will be necessary, these tools being held in the turret and presented in the order named. The open end of the piston is faced by tool *E* mounted on the cross-slide.

TABLE V. MACHINING OPERATIONS ON CRANKSHAFT-MATERIAL, STEEL



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Make center-punch mark at middle of one of center crankpins	....	Hammer and center punch	Inspection	..	..
2	Cut off ends C of drop-forging to reduce crankshaft to length	Special 16-inch engine lathe—double head	V-block fixture with gage to locate work. Extra lathe head. Milling cutters and arbors	Center-punch mark on middle pin	30	1
3	Center ends C	Double-head centering machine	Sliding V-block fixture to accurately locate crankshaft	End bearings and sides of cranks	25	1
4	Rough-turn outside of flange D	16-inch engine lathe	Special driver—"cat-head" type	Centers	30	1
5	Rough-turn rear bearing E	20-inch engine lathe	Special driver—"cat-head" type	Centers	25	1
6	Face down sides F of end bearings	20-inch engine lathe	Locating gage on carriage to enter center-punch mark in crankpin. Double toolpost	Center-punch mark on middle pin	22	1
7	Rough-face sides H of flange D	24-inch heavy-duty engine lathe	Straddle facing tools. Indicator	Centers and finished shoulder on rear bearing	15	2
8	Rough- and finish-turn clutch fit J	20-inch engine lathe	Special driver—"cat-head" type	Centers	15	2
9	Finish-face sides H of flange and under-cut inside of flange	22-inch engine lathe	Straddle facing tools. Special driver	Centers	15	2
10	Rough- and finish-turn front bearing K, gear fit L and threaded end M	20-inch engine lathe	Multiple tools at front and rear of cross-slide to work on all surfaces at once	Centers	17-18	2
11	Finish-turn outside of flange D and rear bearing E	16-inch engine lathe	Special driver	Centers	40	1
12	Drill four holes N through flange D	28-inch vertical drilling machine	Special four-spindle drill head. Jig	Center at bottom and clamp engaging clutch fit J	30	1
13	Turn four crankpins O	21-inch heavy-duty crankshaft lathe	Special tool-holders using high-speed steel cutters	Holes N drilled in flange D	4-5	5
14	Rough-grind crankpins O	Crankshaft grinding machine	Special quick-speed changing mechanism	Centers	10-12	2
15	Finish-grind crankpins O	Crankshaft grinding machine	Steadyrests	Centers	10-12	2
16	Balance	Balancing stand. Grinding stand	....	....	10-12	2
17	Rough-grind rear bearing E	14 by 50 inch plain grinding machine	Special driver	Centers	22	1
18	Finish-grind rear bearing E and face inside of flange D	10 by 50 inch plain grinding machine	Gage for testing finished width of flange	Centers	22	1
19	Finish-grind front bearing K	14 by 50 inch plain grinding machine	Special driver	Centers	22	1
20	Finish-grind outside diameter and outer face of flange D	10 by 50 inch plain grinding machine	Special driver	Centers	20	1
21	Finish-grind clutch fit J, gear fit L, and face-grind gear fit to length	10 by 36 inch plain grinding machine	Special driver	Centers	25	1
22	Ream drilled holes N in flange D	26-inch vertical drilling machine	Special four-spindle drill head. Same type jig as for Operation 12	Center at bottom and clamp engaging clutch fit at top	35	1
23	Mill keyway Q in gear fit	No. 6 hand milling machine	V-block fixture	Front and rear bearings K and E and crankpins O	30	1
24	Drill and ream starting pin hole R	21-inch vertical drilling machine	Quick-change chuck. V-block fixture	Gear fit J and crankpins O	30	1
25	Face clutch fit J to length, and chamfer clutch fit J and flange D	14-inch engine lathe	Files. Gages	Centers	25	1
26	Drill hole S for gear locking screw	21-inch vertical drilling machine	Simple V-block jig. (Accuracy not important)	Crankpins	40	1
27	Drill hole C in starter fit	14-inch vertical drilling machine	Drill jig	Lower center and clamp on gear fit L	50	1
28	Hand-ream flange holes N, starting pin hole R, and hand-tap hole C in end of shaft	Bench	Reamers, tap, tap wrench, vise, etc.	....	35	1
29	Burr shoulders and lap pins O and bearings K and E	14-inch engine lathe	Special lapping handles made of machine steel	Centers	20	1

In estimating production on this job, the tool engineer decides that for the boring operations, a cutting speed of 50 feet per minute can be used, with a feed of 0.040 inch per revolution of the spindle; and that the reaming can be done with hand feed. The length of the cut is ¼ inch, and the feed 0.040 inch per revolution, which is equivalent to 25 revolutions of the spindle per inch; the number of revolutions per minute of the spindle is 56. The length of time necessary to make the rough-boring cut would be $\frac{\frac{1}{4} \times 25}{56} = \frac{7}{56}$ minute = 8 seconds. The finishing cut would take about the same length of time, and the hand-reaming possibly 10 seconds. The length of time necessary to set up and remove the work would be 20 seconds, and the added time for indexing the turret, say, 14 seconds. The total then would be 60 seconds, which is equal to a production of 60 pistons per hour. Since the boring tools are working simultaneously with the facing tool on the cross-slide, the work done by the latter may be neglected in figuring the rate of production, as no extra time is consumed.

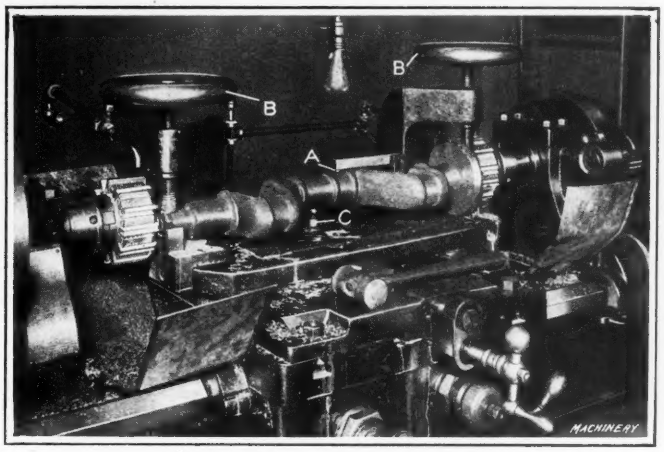
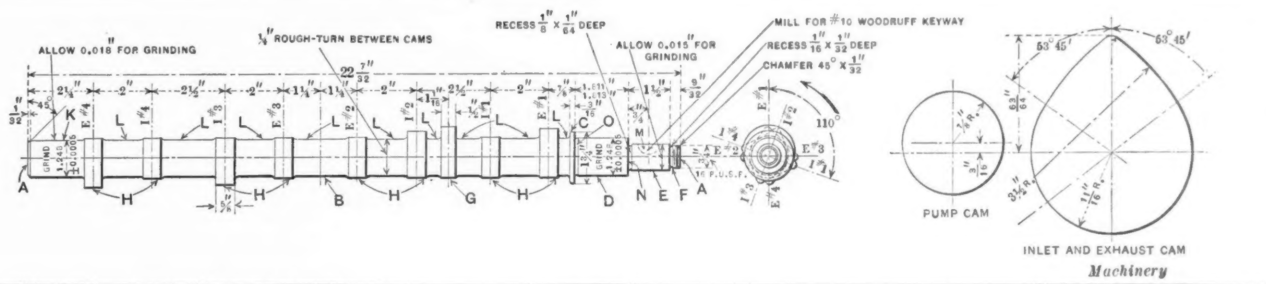


Fig. 11. Greaves-Klusman 16-inch Engine Lathe equipped with Locating Gage to enter Center-punch Mark, Two Headstocks and Milling Cutters for cropping Ends of Crankshaft Forgings to reduce them to Standard Length

Operation 6, Table I.—This is another turret lathe job which consists of rough- and finish-reaming wrist-pin hole *E*. As the open end of the piston has been squared up and reamed to size in a previous operation, this is the logical place from which to locate the work. As a matter of fact, the only object in squaring up the end of the piston and reaming the hole is to provide an accurate locating point for some of the subsequent machining operations. Reference to Fig. 4 will show that the fixture is screwed onto the spindle, and that it is provided with a swinging clamp *A* and hand-screw by means of which the piston is clamped in place after it has been properly located. The piston is first dropped into the fixture in approximately the correct position, after which a piloted bar *B* in the first turret hole is brought up and inserted in the wrist-pin hole. The piston can now be clamped with the assurance that the wrist-pin hole will be in correct alignment. The tools used for rough- and finish-reaming are a four-lipped piloted chucking reamer *C* of the spiral type, and an inserted straight-blade finishing reamer *D*, as clearly shown in Fig. 4.

In determining the production on this job, a liberal allowance must be made for the time occupied in setting up and removing the work, as a certain amount of preliminary aligning is necessary, which requires a little more time than would be necessary on the ordinary type of fixture. The estimate of production for the sequence of movements involved in this operation is as follows: Setting up, locating and removing

TABLE VI. MACHINING OPERATIONS ON CAM-SHAFT—MATERIAL, STEEL



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Crop ends A to reduce to required length	16-inch engine lathe	Arbors with two milling cutters. Work-holding fixture on carriage	Block on fixture that engages cam on forging	30	1
2	Drill center holes in ends A	Double-head centering machine	Center drills	End bearings	25	1
3	Straighten	Straightening press	....	....	40	1
4	Turn steadyrest bearing B, rough- and finish-turn collar C, front bearing D, gear fit E and threaded end F, and rough-turn at sides of pump eccentric G	Multiple turning lathe	Three multiple tool-blocks	....	25	1
5	Face down sides of cams H, pump eccentric G, collar C and bearings D and K	Multiple turning lathe	Steadyrest and driver. Single tool-block with eighteen tools	....	30	1
6	Turn rear bearing K to grinding size, and turn spaces L between cams	Multiple turning lathe	Multiple tool-holder	....	25	1
7	Mill keyway M in gear fit E	No. 6 hand milling machine	V-block fixture	Intake valve cam for No. 1 cylinder	40	1
8	Rough-grind faces of cams H and pump eccentric G	12 by 32 inch cam-shaft grinder	Special driver with locator in keyway M	Centers and keyway	8	3
9	Heat-treat and test hardness	Hardening furnaces	Hardening boxes. Scleroscope	....	..	..
10	Rough-grind front and rear bearings D and K, gear fit E	6 by 32 inch plain grinder	....	Centers	22	1
11	Finish threaded end F	14-inch engine lathe	Center-rest and self-opening threading die	Center and end bearings D and K	40	1
12	Finish-grind cams H and pump eccentric G	12 by 32 inch cam-shaft grinder	....	Centers	8	3
13	Finish-grind gear fit E and shoulder N, front bearing D, face of collar C, rear bearing K and chamfer edge of rear bearing	6 by 32 inch plain grinder	....	Centers	10	2
14	Hone edges off cams H and pump eccentric G	....	Oilstones	....	20	..
15	Final inspection	....	Gages	....	..	..

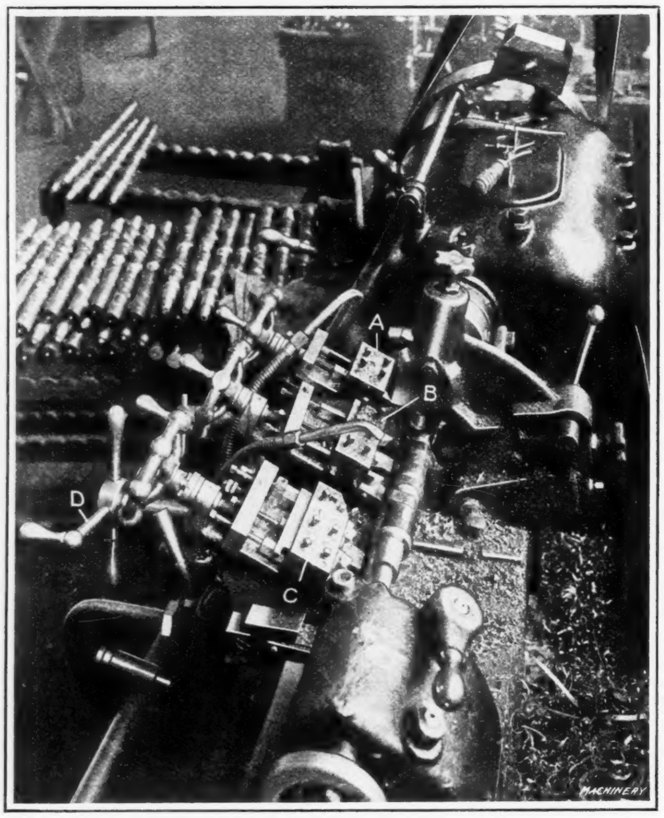


Fig. 12. Fitchburg "Lo-Swing" Lathe tooled up for turning Bearing for Steadyrest; rough- and finish-turning Front Bearing, Gear Fit, Threaded End and Collar; and rough-turning between Cams and Pump Eccentric on Cam-shafts

work from the fixture, 30 seconds. Rough-reaming (at a cutting speed of 60 feet per minute and a feed of 0.062 inch per revolution) would require $\frac{3 \times 16}{240} = 12$ seconds. Finish-reaming would be done by hand, and as only a very light cut is taken it could be safely done at a cutting speed of about 30 feet per minute and completed in about 8 seconds, making the total time for setting up and removing the piece, 50 seconds, or 72 pistons per hour. In connection with this operation, the tool engineer in his preliminary planning decides to make the fixture in such a way that inspection during the process of the work can be easily accomplished. In order to do this, he designs the end of the piston fixture against which the work locates, with a good sized hole in it so that the work can be inspected at any time during the progress of the operation, without withdrawing the tool.

Operation 15, Table I.—This operation shows the value of past experience on the same class of work, as well as the refinements that are sometimes necessary in order to produce the highest quality of finish. The operation, which is illustrated in Fig. 5, consists of turning the piston ring grooves, and it is necessary to have the sides and bottom of these grooves as smooth as possible in order to insure a close fit between the piston and packing rings and at the same time prevent any trouble which might be caused by the accumulation of carbon or other foreign matter that might lodge on the faces of the ring grooves in such a way as to cause the packing rings to stick. In order to avoid this trouble, the tool engineer decides to apply burnishing rolls in the ring grooves after they have been turned, and thus leave them in an ideal condition. He decides to hold the work on a special nose-piece fitting in the open end of the piston and provided with a driver that engages one of the wrist-pin bosses on the inside of the piston. The tailstock center of the lathe supports the other end of the work, and makes the method of holding very secure.

For this operation of turning and burnishing the piston ring grooves, a special tool-block *A* is placed on the front of the cut-off slide and the tools carried by this block are used to dress off the sides of the grooves before the burnishing tools *B* are used. Hand feed is employed for cutting the grooves and burnishing them to obtain a high quality of finish. For this reason, the time necessary to complete the operation must be somewhat arbitrarily decided by the tool engineer. In deciding the length of time needed for this operation, the method of procedure would be about as follows: Setting up and removing work, 30 seconds; estimated time for finishing cut on ring groove, 20 seconds; estimated time for burnishing the groove, 40 seconds; total time necessary for this operation, 90 seconds, giving a production of 40 pistons per hour.

Machining Operations on the Cylinder Block

In taking up the design of tools and selection of locating points for machining the cylinder block, and in estimating the production obtained, the tool engineer must consider a number of factors that govern the performance of certain operations, and he may deem it advisable in some cases to build special machinery to handle such operations on the cylinder block. The operation and tool list for this piece, presented in Table III, shows the first machining operation to consist of milling the top and bottom surfaces *A* and *B*, surface *C* around the valve ports, and seat *D* for the valve dust plate. In considering the points from which to locate the work during this operation, the tool engineer must consider the probability of variations in the castings. This point is particularly important in a casting of this nature which has a number of cored openings. The method of setting up for the milling operations must be so arranged that important surfaces will be located so that there will be sufficient finish allowance to permit of taking a good finishing cut when machined to the sizes called for.

In this case the crankshaft bearing hole at each end and the bottom surface of the valve chamber are selected as locating points, and the fixture is designed to work from these surfaces. By this selection it is certain that sufficient stock will be left to give a good finish in machining; and also that the inside clearances for the moving parts will be uniform so that there will be no chance of interference. Owing to the variations in the castings, fixed points of location cannot be used and jacks must be utilized in connection with special gages to bring the work up to the proper height for machining. The machine on which the work can be done to the best advantage is a planer type milling machine with three spindles, having a table long enough to hold eight cylinder castings at a time. The fixture must be so designed that the clamps can be conveniently operated, and they must take up very little space longitudinally in order that the maximum number of castings can be set up on the table at a time. The right-hand free-hand sketch in Fig. 1 indicates clearly the tool engineer's conception of the proposed method of handling this operation on the cylinder blocks.

In estimating production on this work, the total distance that the milling machine table travels must be carefully figured, allowing sufficient space between the cylinders for the clamps and taking into consideration the diameter of the cutters used, etc. In this case the distance to be traveled is approximately 176 inches, which includes the space allowed between the cylinders to leave room for clamping. The feed per revolution of the cutter is 0.250 inch and the cutters are 10 inches in diameter; they should revolve at a speed of 24 revolutions per minute, equal to a cutting speed of about 60 feet per minute. An inspection of these points will show the tool engineer that the feed is 6 inches per minute in longitudinal travel of the table. Hence, the length of time necessary to feed the table carrying eight cylinder blocks past the milling cutters is $\frac{176}{6}$, or approximately 30 minutes. Allowing about 12 minutes for a man and a helper to set up the work for another operation and remove the cylinders that have been machined, gives a total of 42 minutes for the eight cylinders. This is approximately one cylinder every 5 minutes, or 120 cylinders per day. As this is in excess of half the production wanted, two machines will be necessary to give the required output. The milled cylinder blocks are removed from the table as they pass out from under the rail; and fresh castings are set up as soon as the return stroke of the table

has been completed, the first casting being placed in the fixture nearest the cross-rail so that the next milling operation can be started at once. In this way the factor of idle time on the machine is partially done away with. It will be seen that one man's time will not be fully occupied in attending to one of the milling machines, and in order to keep him busy, the tool engineer plans to arrange a vertical drilling machine close to the milling machines, so that the operator can fill in with a little work on this machine while waiting for the milling operations on the cylinders to be completed. The work selected for these men to do is indicated by Operation 3 in Table III.

It still remains to provide some fixed point that can be used to locate the work for the majority of machining operations that still have to be performed. For this purpose the tool engineer decides to drill two dowel-pin holes at diagonal corners of the base; and these are used to receive locating pins on the fixtures employed in the majority of the subsequent machining operations. As the holes are a considerable distance apart, it is practicable to use a two-spindle drilling machine, in the spindles of which can be placed quick-change chucks so that reamers can be substituted for the drills after the drilling has been done. It must be remembered that in designing fixtures or jigs for a heavy piece like the cylinder block, the question of operating the jig or fixture and placing the work in position must be carefully considered with a view to making it as convenient and quick as possible. The design should also be worked out in such a way that the operator will not be likely to injure himself by having to pull and haul the work into its proper location in the fixture.

Fig. 6 shows the fixture used for Operation 3, Table III, in connection with which several points of interest may be noted. In order to make the operator's work as easy as possible, and to prevent improper location of the work due to the accumulation of chips in the fixture, the cylinder block is placed on two steel rails or guides *A* and slid back until a pad on the fixture engages a finished face previously milled on the casting. The longitudinal location is controlled by means of the swinging clamp and locator, and it will be noted that one of these clamps is operated through a handwheel *B* conveniently placed. The entire fixture is rigidly clamped to the drill press table. Owing to the fact that the holes are reamed in this operation, in addition to being drilled, the drill bushings are made removable so that they can be replaced by those used for guiding the reamer; and quick-change chucks *C* are provided on the drill spindles to facilitate changing the tools.

In estimating production on this piece, a liberal amount of time should be allowed for setting up and removing the work, not because of the difficulty of clamping it or removing it from the fixture, but because the casting itself has considerable weight and cannot be as easily handled as a lighter one. Time must also be allowed to remove the drill bushings from the jig and replace them by the reamer bushings, and *vice versa;* also, to remove and replace the drills and reamers in the quick-change chucks. Two minutes should be a generous allowance for the movements having to do with the setting up and replacement of tools; and the drilling and reaming operations would be comparatively short, a reasonable estimate being somewhat less than one minute for the two operations. Thus a little less than three minutes would be ample for drilling and reaming one piece, and as the production is slightly more than one piece in three minutes, the tool engineer calls the estimate about 22 pieces per hour, so that one machine is capable of giving the required production.

Operation 15, Table III.—This operation consists of boring and facing valve seats *N* and holes *O*, and drilling and reaming guide bushing holes *P* and *Q* for the valve stems and push-rods. The concentricity of these holes is important, and there are a number of them to be machined; also the depth of valve seats *N* is of importance, in order that the seating of the valves may be uniform. Taking all these points into consideration, the tool engineer decides that it will be advisable to employ a gang of drilling machines of the eight-spindle vertical type so that the various operations on the valve holes and push-rod holes can be performed in sequence, without necessitating a change in tools. Fig. 7 shows the way in which the machines were finally set up, and it will be seen that a system of roller conveyors is provided for handling the heavy castings as easily and rapidly as possible. In deciding upon the use of this equipment, a number of points were studied in connection with handling the work—both at the actual time of machining and also before and after performing the operations. Provision of the conveyor system is a case in point, as well as the arrangement of the machines. The conveyor is in the form of an oval, portions of which are seen in the illustration; one side of the oval is unbroken, while the other has four openings to receive the machines. It will be seen that by this arrangement, one or more men can be employed in loading the fixtures or removing the work, while the men at the machines have nothing to do except to attend to the actual machining operations.

In designing the fixtures used for this series of operations, the tool engineer decides to make all the fixtures alike, with the exception of the jig plates *A* which are made removable and interchangeable between the fixtures. This design makes it possible for each fixture to be moved along from one machine to another. At the conclusion of each operation, the plate that has just been used is removed from the fixture, and the fixture is then pushed along to the operator of the next machine, who merely clamps the proper jig plate onto the fixture, when it is ready for use. In regard to the design of tools, the first set *B* consists of combination four-lipped drills and angular countersinks for machining the valve seats, the second set *C* consists of drills for drilling the valve stem bushing holes; and the third set *D* consists of drills for drilling the push-rod bushing holes. In estimating the production on

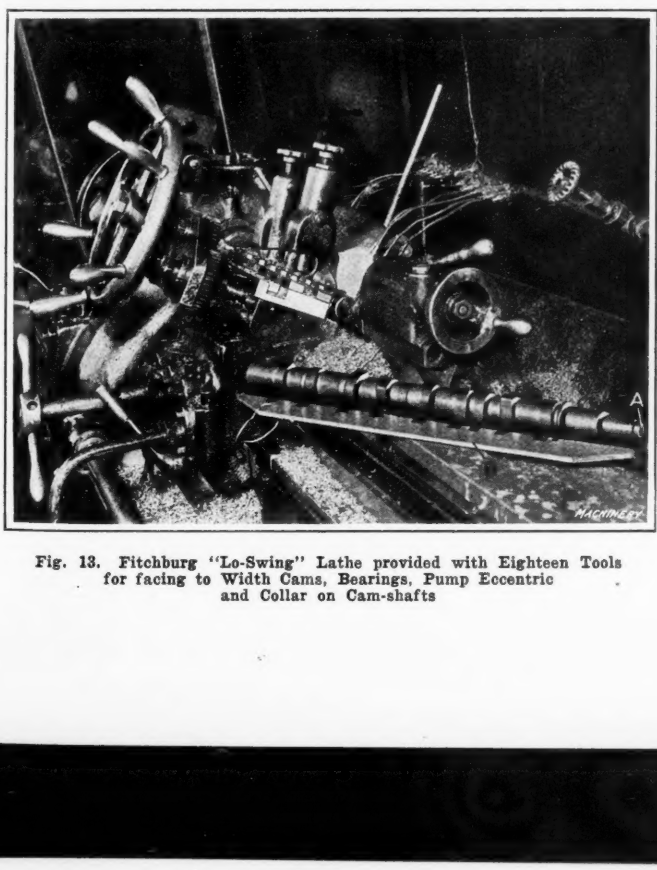


Fig. 13. Fitchburg "Lo-Swing" Lathe provided with Eighteen Tools for facing to Width Cams, Bearings, Pump Eccentric and Collar on Cam-shafts

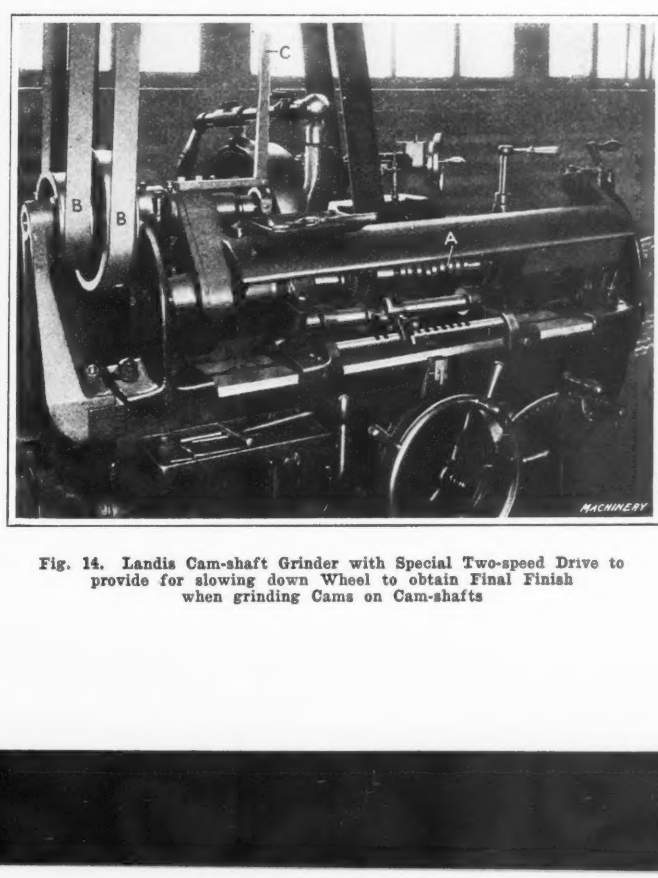
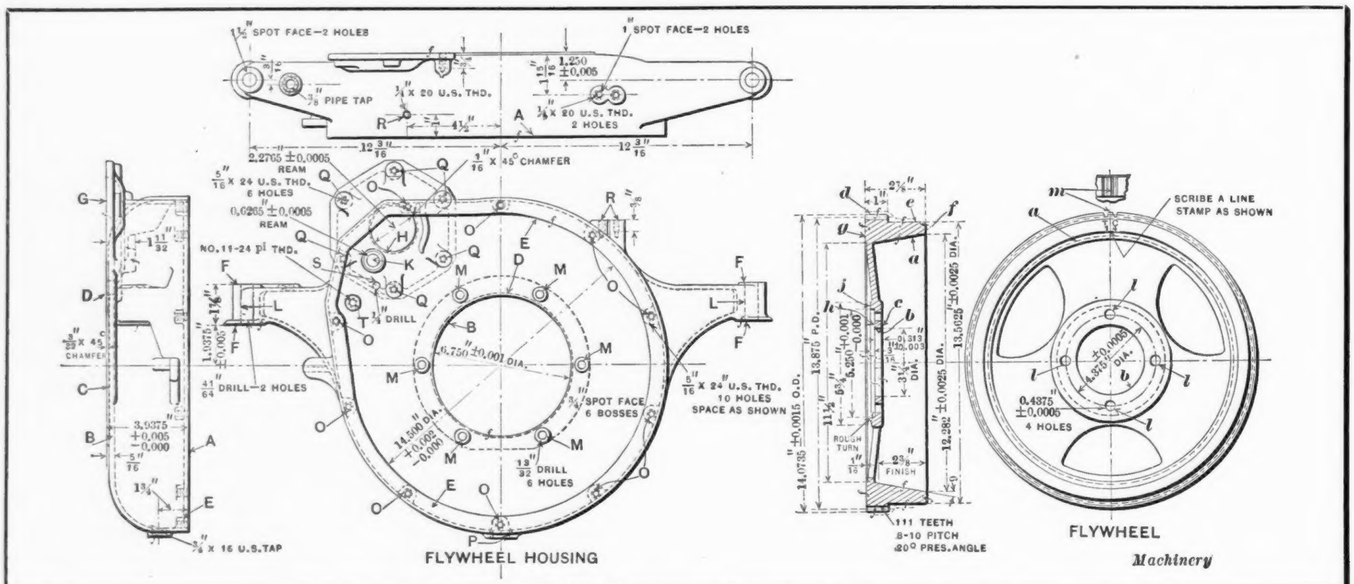


Fig. 14. Landis Cam-shaft Grinder with Special Two-speed Drive to provide for slowing down Wheel to obtain Final Finish when grinding Cams on Cam-shafts

this series of operations, it is only necessary to figure the length of time required for changing the jig plates and for completing the longest operation. Assuming hole *Q* to be the longest operation, we find that the diameter of the hole is 0.6875 inch, and for a cutting speed of 50 feet per minute, the drills should be run at a speed of about 270 revolutions per minute. The depth of the hole (taking into consideration the drill point) is 1½ inch; and a feed of 0.010 inch per revolution can be safely used on this work. The number of revolutions required to drill the hole would be $1.5 \div 0.010 = 150$. The actual machining time is $150 \div 270$ = a trifle over ½ minute. Considering idle movements of the drill head, ¾ minute should be allowed for the actual machining time. Adding 1 minute for setting up the work and ¾ minute for handling the fixture, we have a total of 2½ minutes, which is equal to a production of 24 pieces per hour.

Operation 25, Table III.—In planning the sequence of machining operations on the cylinder block, the tool engineer has called for the drilling of forty-eight holes, *a*, *b*, *c*, *d*, *e*, *f* and *g* in the cylinder block casting, working from four sides at once. In order to accomplish this operation in the minimum time, a special machine is necessary that is arranged with four separate heads, each of which has a series of drills grouped in such a way that the spacing will correspond to the required location of the holes in the various parts of the cylinder block. This machine is shown in Fig. 8, the locating points for this operation being the dowel holes drilled in the base of the cylinder block. In deciding upon the best type of jig to use for this

TABLE VII. MACHINING OPERATIONS ON FLYWHEEL HOUSING AND FLYWHEEL—MATERIAL, CAST IRON



MACHINING OPERATIONS ON FLYWHEEL HOUSING

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Rough-mill face A of transmission flange	No. 5 vertical milling machine	Clamping fixture	Under side of casting	12	2
2	Grind face A of transmission flange	No. 2 horizontal disk grinder	....	....	25	1
3	Rough- and finish-bore crankshaft bearing hole B, face surface C and counterbore at D	25-inch heavy-duty turret lathe	Clamping fixture on faceplate	Finished face A of transmission flange	12	2
4	Bore inside edge E of transmission flange	25-inch heavy-duty turret lathe	Clamping fixture on faceplate	Hole for crankshaft bearing	20	1
5	Straddle-mill suspension arms F	No. 3 horizontal milling machine	Two fixtures; one at each end of table. Adjustable locators for rough and finished bosses	Inside edge E of transmission flange and suspension arms F	22	1
6	Mill seat G for self-starter box	No. 5 vertical milling machine	Clamping fixture	Inside edge E of transmission flange and suspension arms F	20	1
7	Bore, ream and chamfer hole H for self-starter box bearing	26-inch vertical drilling machine	Quick-change chucks	Face A of transmission flange, suspension arms F and crankshaft bearing hole B	24	1
8	Drill and ream sliding gear shaft hole K	20-inch vertical drilling machine	Quick-change chucks. Jig plate	Starter box hole H, and hole B for crankshaft bearing	30	1
9	Drill hole S and No. 11 hole T, and spot-face hole T	14-inch two-spindle drilling machine	Quick-change chucks. Jig plate	Starter box hole H, and hole B for crankshaft bearing	25	1
10	Drill bolt holes L in suspension arms F	20-inch two-spindle rail drill	Jig	Suspension arms F and face A of transmission flange	30	1
11	Drill six holes M around crankshaft bearing and six holes Q around starter box	Multiple spindle drilling machine	Same type jig as for Operation 8	Same as for Operation 8	25	1
12	Drill ten holes O in transmission flange A	Multiple spindle drilling machine	Drill jig	Crankshaft bearing hole B and starter box bearing H	25	1
13	Drill, spot-face and tap drain plug hole P	20-inch vertical drilling machine	Quick-change chucks. Jig	Crankshaft bearing hole B	20	1
14	Spot-face inside of boss around sliding gear shaft K and around six holes M	20-inch vertical drilling machine	Quick-change chucks. Piloted spot-facing tools	Holes to be spot-faced	25	1
15	Drill control bosses R	14-inch vertical drilling machine	Jig	Hole B for crankshaft bearing and hole K for sliding gear shaft bearing	30	1
16	Tap six holes Q in starter box seat, No. 11 hole T, three holes R in control bosses, and ten holes O in transmission flange	No. 2 automatic tapping machine	Quick-change chucks	....	12	2
17	Wash	Soda kettle	....	....	..	1

TABLE VII. MACHINING OPERATIONS ON FLYWHEEL HOUSING AND FLYWHEEL—CONTINUED

MACHINING OPERATIONS ON FLYWHEEL

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Rough and finish clutch fit a, bore and ream hole b, face inside c of hub, turn two outside diameters d and e, face inside and outside f and g of rim, and put radius on all edges	Semi-automatic chucking machine	Two complete sets of the following tools for each machine, for roughing and finishing: Turret tools turn outside diameters, bore and face flange, and turn tapered clutch fit. Tools at front of cross-slide face edges of rim and starter gear d to width. Tools at back of slide finish same surfaces and chamfer corners	Inside edges of cored holes in web	4	6
2	Counterbore and face fit h for flange on crankshaft, and face surface j around flange fit	No. 6 turret lathe	Turret tools and special work-holding fixture on face-plate	Taper clutch fit	11	2
3	Drill and ream four holes l for crankshaft flange bolts	22-inch vertical drilling machine	Plate jig and drill head	Crankshaft flange fit h	22	1
4	Cut teeth m for starter	Fellows gear shaper	Fixture to hold two flywheels at a time. Fellows gear shaper cutters	Reamed center hole b	8	3
5	Balance	Combination drilling and balancing machine	....	....	10	2

operation, the tool engineer decides that it should be so made that it can be fastened permanently to the drilling machine table. The jig must also be so arranged that the cylinder block can be placed in position without difficulty, and for this reason the locating dowels are placed in a sliding plate *A* that is arranged to slide along a pair of ways so that it can be pushed into position and located by an index pin *B* as indicated, or pulled out for the purpose of loading.

There are several features of importance in connection with this operation, which were carefully studied by the tool engineer in planning this operation. One of these is the provision of a rapid method of clamping the work. The two clamps *C* and *D* of irregular shape, which are seen at the right- and left-hand sides of the fixture, are bolted down tightly onto the top of the cylinder block after it has been pushed back into the position shown. The top jig plate *E* is connected to the vertical spindle head in such a way that the drills are always located in the bushings on this plate. On the under side of this jig plate there are dowels which enter holes in the upper part of the fixture when the spindle head is brought down preparatory to drilling. Coil springs *F* are interposed between brackets on the under side of the head and the top of the jig plate, so that a moderate pressure is exerted during the drilling, and at the same time the drills are allowed to feed down through the plate, the movement being compensated for by the springs. The other three faces of the jig are fitted with the usual form of jig bushings to support the drill.

Reference to the illustration at the top of Table III will show that all holes drilled in this operation are of small size and of comparatively slight depth, so that the actual time occupied in drilling the holes is very small. Considering that 1 inch is the maximum travel of any drill in the group, and that the drill speeds are about 300 revolutions per minute with a feed of 0.010 inch per revolution, about 100 revolutions would be necessary to obtain the proper depth of hole. Hence, the length of time necessary would be $\frac{100}{300} = 1/3$ minute $= 20$ seconds. The movement of the head, setting up of the work, and other incidental movements in connection with handling, can be safely estimated at 1½ minute, or, say, 2 minutes for each complete piece from floor to floor. This would give an hourly production of 30 pieces, which is more than sufficient for the requirements of the case under consideration.

Operation 30, Table III.—This operation consists of tapping fourteen holes *c* in top and seventeen holes *R* and *k* in bottom of cylinder block. As planned by the tool engineer, this operation is done on a vertical tapping machine of the automatic type, two of which are shown in Fig. 9. In order to facilitate handling the work during this operation, the two automatic tapping machines are arranged with a special table, so that the cylinder blocks can easily be pushed along from the spindle of one machine to the other. As there are fourteen holes to be tapped in the top of the cylinder and seventeen in the bottom, it follows that the man who is working on the top of the cylinder should have a trifle more time at his disposal than the one who is tapping the holes in the bottom. Therefore, when this man finishes a piece he turns it over onto the other end, ready for the next man to start work. In figuring the production on this operation, the tool engineer estimates that it will take approximately 10 seconds to tap each hole, back out the tap, and bring the next hole under the spindle, so that the longest operation would be $17 \times 10 = 170$ seconds, or a trifle under 3 minutes. The other man, with only fourteen holes to tap at the same rate, would have 30 seconds to spare, in which time he can turn the cylinder over, ready for the seventeen-hole man. A production of one piece every three minutes from the two machines working on what are virtually separate operations, gives a production of 20 pieces per hour.

Machining Operations on Cylinder Head

Referring to the operation and tool list shown in Table IV, it will be seen that the first operation on the cylinder head consists of face-milling fourteen bosses *C* for the hold-down bolts. The points from which the piece is located in this operation are the cored interiors of the combustion chambers at opposite ends of the cylinder head. The fixture used is of the plate type and has properly located lugs attached at each end to conform approximately to the contour of the cored inside of the combustion chambers. The cylinder head is pushed up against these lugs on the fixture in order to give a location from the cored inside of the combustion chambers. Suitable clamps are provided on the fixture to hold the work down while the bosses are profiled with an end-mill mounted in the spindle of the one-spindle profiling machine, the operator following the bosses without using a forming plate.

Operation 8, Table IV.—This operation consists of drilling and tapping hole *H* in the fan stud boss *F*. Previous to this operation, the cylinder bolt holes have been drilled and the under side of the head has been milled so that in Operation 8 the milled surface and two of the bolt holes near the fan stud boss are used as locating points, studs being provided on the angle-plate fixture to enter the holes mentioned. In order to avoid the necessity for a second setting of the work in drilling and tapping hole *H*, the construction of the drill press was modified in rather an interesting manner suggested by the tool engineer. Referring to Fig. 10, it will be seen that the fixture itself is of the angle-plate type, which is set up on the bed of the drilling machine on a box section of cast iron in order to obtain the proper height. The table of the drilling machine is swung to one side, where it is out of the way. The drilling machine selected for doing this work is a 21-inch vertical machine on which the automatic knock-out

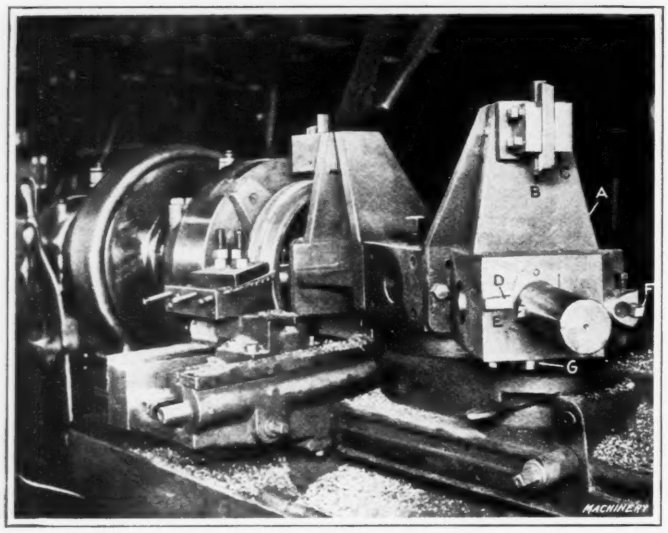


Fig. 15. No. 6 Potter & Johnston "Automatic" tooled up for turning and boring at One Setting All Surfaces on Flywheels except Crankshaft Flange Fit

for the drill feed remains standard, with the exception of the rear end of the stop which is expanded to form a dog that governs the reversal of the tap.

For tapping, an adjustable scale *A* is provided on the machine, which may be set to permit the reversing mechanism to be operated when the hole has been tapped to any desired depth within the range of the tapping attachment, the reversal being obtained by having the dog run off scale *A* so that weight *B* may throw lever *C* to reverse the clutch. The tap is backed out in this way, but it would not be lifted from the work were it not for weight *D*, which is supported by a cable wrapped around the hand-feed shaft, which exerts just sufficient pull to lift the spindle after the tap clears the work. By referring to the illustration, it will be noted that the method of holding the work on the fixture is ingenious; this is accomplished by a single hook bolt *E* having a long head, which is simply swung into place and drawn back against the work. A quick-change chuck is used to hold the drill and tap used for this work.

In estimating the production on this job, the time allowance for setting up and removing the work would not be very great, say ¾ minute, while the exchange of the drill and tap in the quick-change chuck and *vice versa* should only require another 15 seconds, making one minute in all for setting up the work and changing the tools. A drill ⅝ inch in diameter, running at a cutting speed of 50 feet per minute, should be run at about 300 revolutions per minute to give the required cutting speed; the depth of the hole is 1½ inch and the proper drill feed about 0.010 inch per revolution. Therefore, 150 revolutions would be necessary to drill the hole. This would require ½ minute, and allowing about 50 per cent more time than this for tapping the hole, 1¼ minute would be the total cutting time on this piece, or 2¼ minutes for setting up, removing, drilling and tapping. On this basis it is safe to assume that 25 pieces per hour can be produced on one machine, which is ample for the requirements of the case under consideration.

Machining Operations on Crankshaft

Referring to Table V, it will be seen that the first machining operation on the crankshaft consists of placing a center-punch mark at the middle of one of the center crankpins, which is used to locate the work for subsequent operations. The second operation consists of cutting off ends *C* of the drop-forging to reduce the crankshaft to its proper length. The locating points for this operation are two V-blocks, one at each end of the fixture, in which the small ends of the crankshaft rest. In order to cut off the ends of the shaft in such a way that sufficient allowance for finish will be left on all the points that are to be machined, some locating point is necessary, other than that provided by the rough forging. For this reason, the center-punch mark is placed on one of the center crankpins, the punch mark being so placed (by inspection) that it will allow a sufficient amount of stock to enable all pins and bearings to "clean up" properly. A gage point *A*, hung in a swinging bar mounted on the lathe, as shown in Fig. 11, enters the center-punch mark on the crankpin, when the crankshaft forging is properly placed in the V-blocks. After this location has been determined, the clamp at each end of the fixture is tightened to hold the work down, the operation of these clamps being controlled by handwheels *B*. A jack *C* is also used under the center crankpin to support the overhang of the crankshaft. The machine which the tool engineer decides to use for this operation is somewhat unusual, consisting of a standard engine lathe equipped with two opposed spindles and provision for the attachment of face milling cutters to the end of each spindle. The fixture is mounted directly on the carriage of the lathe in such a way that the cross-feed screw can be used to feed the work past the milling cutters and thus crop the ends off the forging. As the crankshaft is a drop-forging, the greatest care must be taken to see that sufficient stock is left at all points to permit of machining within the required limits.

In estimating production on this job, it is necessary to take into consideration the centering operation, the setting in place and removing of a rather heavy piece, and the tightening and loosening of the clamps on the fixture. The tool engineer decides that about 1½ minute should be sufficient for these movements, so that nothing remains to be figured except the actual time required to take the cut. For this work it is safe to specify a cutting speed of 60 feet per minute, with a feed of 1/16 inch per revolution of the cutters. The length of travel necessary is 1¼ inch, and the diameter of cutters, 6 inches. A cutting speed of 60 feet per minute with cutters of this diameter means that the spindle must revolve at 40 revolutions per minute; and as the length of cut is 1¼ inch, 20 revolutions of the cutter at a feed of 1/16 inch per revolution would be sufficient to complete the cut. This would require ½ minute, making a total time for cutting off each crankshaft 2 minutes, or 30 pieces per hour.

Machining Operations on Cam-shaft

Referring to Table VI, it will be seen that Operation 1 consists of cropping the ends *A* of the cam-shaft to reduce it to the required length, the operation being performed in much the same manner as that just described for the crankshaft. The locating point for this first operation is one of the cams, which strikes against a protruding lug on the fixture to give the required longitudinal location. After the location has been determined in this manner, the work is clamped in the fixture which is similar to the one used for cropping the crankshaft. After this, the milling cutters remove the stock from the ends of the cam-shaft forging.

Operation 4, Table VI.—This operation consists of turning the center bearing; rough- and finish-turning the collar, front bearing, gear fit and threaded end; and rough-turning the

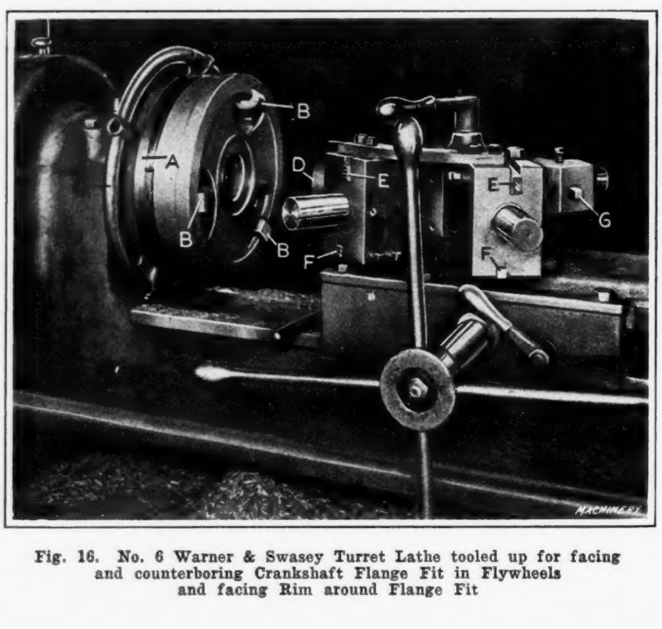


Fig. 16. No. 6 Warner & Swasey Turret Lathe tooled up for facing and counterboring Crankshaft Flange Fit in Flywheels and facing Rim around Flange Fit

cam-shaft forging between the cams and pump eccentric. For this operation the work is located on centers on a multiple turning lathe provided with an arrangement of tools so spaced as to enable them to take cuts over the various surfaces mentioned. The tools for these operations are carried by three multiple tool-blocks *A*, *B* and *C*, Fig. 12, arranged on the slide in such a way that any set of tools may be fed in to the working position by turning the proper handwheel. All the tool-blocks are traversed longitudinally at the same time by turning handwheel *D*, but there is only one set of tools in the cutting position at one time.

In estimating production on this piece, it is necessary to consider the longest cut which has to be taken, this being about 2 inches. The material from which the cam-shaft is made will permit of employing a cutting speed of from 35 to 40 feet per minute for the roughing cut, where the removal of stock is about normal. In order to be conservative, the tool engineer takes the lower figure, with a feed of about 0.020 inch per revolution. The average diameter of the work is 1½ inch, so that 95 revolutions per minute will give the proper cutting speed; and as the length of the cut is 2 inches, it requires 100 revolutions, or a trifle over 1 minute, to complete the cut. For adjusting the tools and running them back out of the way after the cut is finished, ½ minute might properly be allowed, and for setting up and removing the work, about ¾ minute, making 2¼ minutes the time required for performing the entire operation. A production then can be assumed of 25 pieces per hour. The machine tooled up for this operation is shown in Fig. 12.

Operation 5, Table VI.—This operation consists of facing down the sides of the cams, bearings, pump eccentric and collar *C*. A multiple turning lathe is also used in this case, and the work is held on centers as in Operation 4. In this case, a single tool-block is employed, using eighteen tools that are so set as to give the correct spacing for the various shoulders on the cam-shaft; and a large handwheel is employed for feeding the tools down into the work. Fig. 13 shows the equipment, together with a cam-shaft *A* which has just been machined and the gage *B* used for determining the accuracy of spacing of the shoulders on the shaft.

In estimating the production time on this piece, it can properly be assumed that the time for setting up and removing the work will be about the same as for the previous operation, *i. e.*, about ¾ minute. The feed in this instance is by hand and must be rather fine on account of the large number of tools that are working at one time; but the depth to which the tools must be fed is quite small, the greatest distance which any one tool travels being only about ⅜ inch. The speed for a cut of this kind can be about the same as that employed in the preceding operation, *i. e.*, 95 revolutions per minute. Allowing a feed per revolution of about 0.003 inch, 125 revolutions will be necessary to feed the tools in to depth. This would require a trifle over 1¼ minute, which, in addition

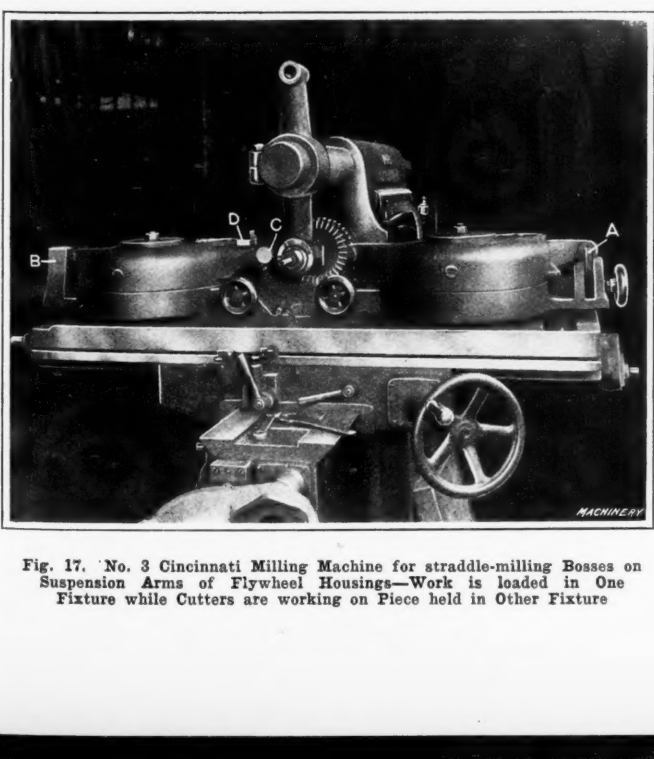


Fig. 17. No. 3 Cincinnati Milling Machine for straddle-milling Bosses on Suspension Arms of Flywheel Housings—Work is loaded in One Fixture while Cutters are working on Piece held in Other Fixture

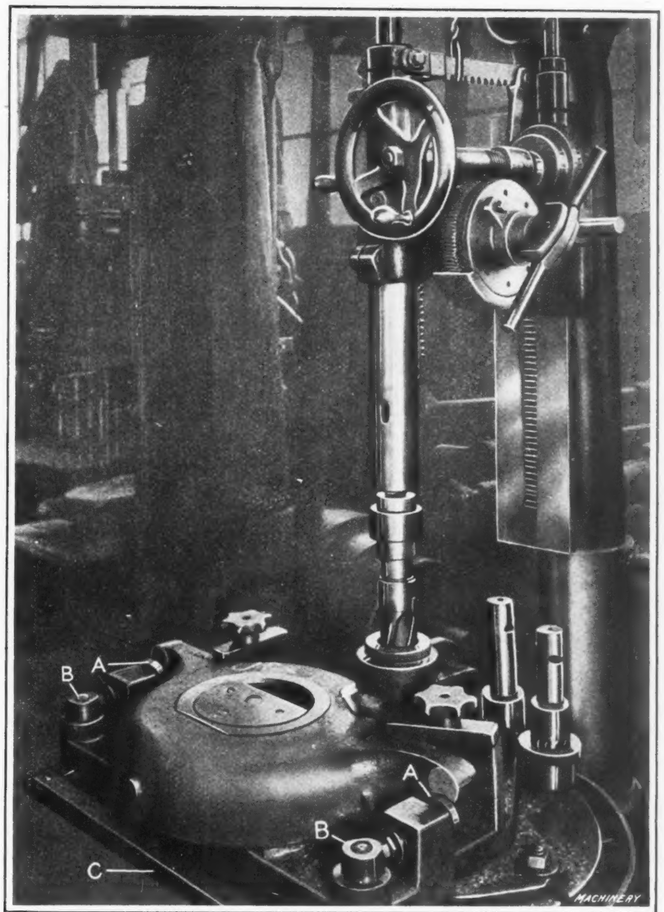


Fig. 18. Reed-Prentice 26-inch Upright Drill equipped with "Magic" Quick-change Chuck, Tools and Jig for boring, reaming and chamfering Hole for Starter-box Bearing on Flywheel Housings

to ¾ minute for setting up, would give 2 minutes, or a production of about 30 pieces per hour.

Operation 8, Table VI.—This operation consists of rough-grinding cams *H* and pump eccentric *G*. The work is held on centers, and the keyway for the cam-shaft gear is used to obtain the correct radial location for the work. In planning this grinding operation, the tool engineer considers the fact that a special cam-shaft grinder is made for work of this kind, and so he takes up the matter direct with a well known builder of cam-shaft grinding machines, allowing this firm to figure the production and submit an estimate on it. In this case, the production was given as 8 cam-shafts per hour for each machine, and so the tool engineer saw that three machines were necessary in order to give the required output. Fig. 14 shows one of the cam-shaft grinders, and this view clearly shows the master cam-shaft *A* with the controlling cams, and other features of interest. Particular attention is called to the special arrangement of the two driving belts and pulleys *B* that have a friction clutch between them which is controlled by the hand-lever *C*; this enables the bulk of the surplus stock to be ground away at high speed, after which the clutch is thrown over to engage the slow-speed pulley for completing the operation. Practically no time is lost in making this change.

Machining Operations on Flywheel

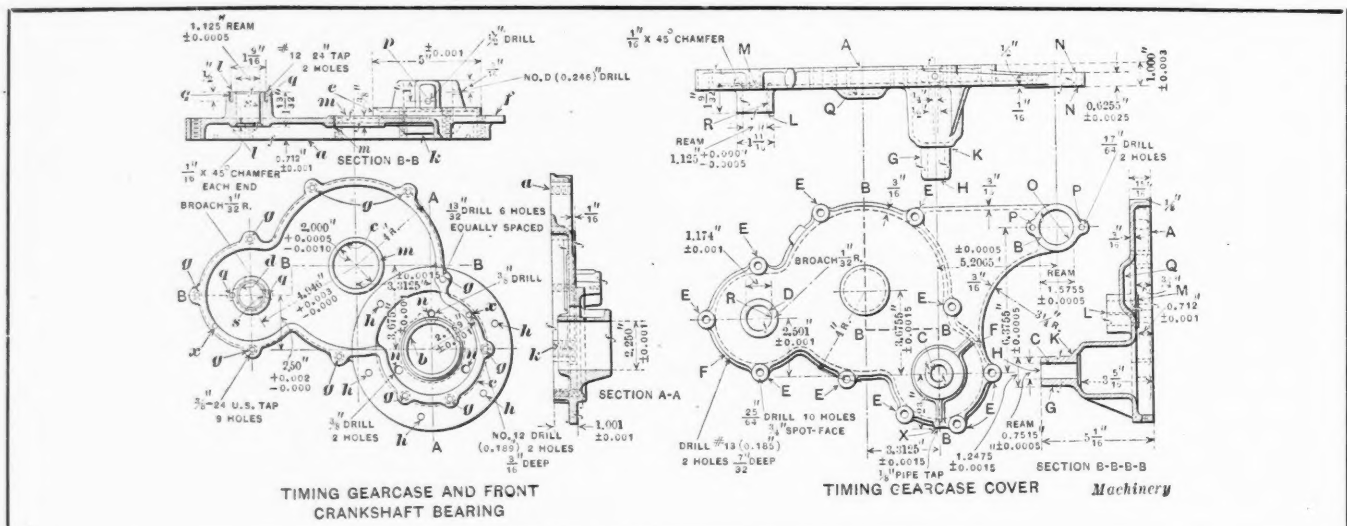
Operation 1, Table VII.—The first operation on the flywheel, as shown on the operation and tool list presented in Table VII, consists of boring taper clutch fit *a*; boring and reaming hole *b*, and facing inside of hub *c*; turning two outside diameters *d* and *e*; facing front and back edges *f* and *g* of the rim and putting a radius on all edges. It is very important in machining an automobile flywheel to hold the work in such a way that there will be no possibility of its slipping during the process of machining; and as the cuts are usually very heavy, it is good practice to hold the work so that the required driving power can be obtained without setting the chuck jaws up tight enough to distort it. If a method of holding can be so devised that advantage is taken of some

adequate driving surface on the work, much more satisfactory results are likely to be obtained. In the present case, the design of the flywheel lends itself admirably to holding, for the first setting, in a three-jaw geared scroll chuck, the jaws of which can be inserted through the cored holes in the web of the flywheel in such a way that one jaw engages the edge of the cored hole and constitutes an efficient driver. Special jaws are provided for the chuck, which are so designed that they will grip the web in the cored openings and at the same time leave the necessary clearance between the work and body of the chuck so that face *f* of the rim can be machined at the first setting. The jaws must also allow room enough to bore the taper of the clutch fit *a* without interfering.

The machine selected for doing this work is a heavy type semi-automatic chucking machine provided with an exceptionally efficient tool equipment which enables it to turn out the work in an unusually short time. Great care was exercised in the design of tools for this operation in order to have as many combinations of cutting tools as possible working at the same time, and thereby lose a minimum amount of time during the machining operations. Reference to Fig. 15 shows the general arrangement of the tools. In developing the design it was decided to arrange special tools on the turret which provide for simultaneously turning the rim to both diameters, facing the inner hub, boring the straight hole in the hub, and boring the tapered clutch fit by means of a generating tool which gives better results than would be obtained with a form tool. The body of tool-holder *A* is bolted on the turret; and it is ribbed to form a rigid support for the overhead tools *B* and *C* that turn the two diameters on the rim, these tools being carried by a special tool-block. The lower portion of tool-holder *A* is carried forward sufficiently to overhang the cross-slide on the machine, and is provided with facing tool *D* for machining the hub, and piloted boring-bar *E* for finishing the straight hole in the hub.

The inside taper-boring tool *F* is arranged in an interesting way, being mounted in a bar which is a running fit in a hole through the body of the tool-holder. A slot in the under side of the tool-holder allows for movement of a stud that extends downward from bar *F* and carries a hardened and

TABLE VIII. MACHINING OPERATIONS ON TIMING GEAR-CASE AND COVER—MATERIAL, CAST IRON



MACHINING OPERATIONS ON TIMING GEAR-CASE

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Mill face of flange a	No. 5 vertical milling machine	Clamping fixture to hold two castings	Under side of casting	20	1
2	Disk-grind face of flange a	No. 2 disk grinder	....	....	40	1
3	Bore and ream bearing holes for crankshaft b, cam-shaft c and magneto shaft d	28-inch vertical drilling machine	Quick-acting chucks. Special three-spindle drill head	Outside of crankshaft bearing boss and inside of magneto gear housing	25	1
4	Turn outside of crankshaft bearing boss e to diameter of 5 inches and face surface f surrounding boss	30-inch vertical boring mill	Special fixture	Machined holes for crankshaft bearing b and magneto shaft bearing d	30	1
5	Drill ten holes g in flange	Multiple spindle drilling machine	Jig on ways to run out from under spindles. Jig supported on trunnions to swing over for loading	Machined holes for crankshaft bearing b and magneto shaft bearing d	30	1
6	Drill five holes h in front crankshaft bearing flange	24-inch vertical drilling machine	Jig plate fits over 5-inch bearing boss e. Six-spindle special drill head	Turned crankshaft bearing boss e and pin in drilled hole	60	1
7	Spot-face inside of crankshaft bearing hub k	21-inch vertical drilling machine	Fly-cutter with pilot to enter bearing hole b	Turned crankshaft bearing boss e and pilot on cutter	60	1
8	Spot-face inside and outside of cam-shaft bearing boss m	24-inch vertical drilling machine	Piloted spot-facing tool	Cam-shaft bearing hole c and flange a	35	1
9	Spot-face inside and outside of magneto shaft bearing boss l. Chamfer edges of hole d	24-inch vertical drilling machine	Piloted spot-facing tool, chamfering tool and quick-change chucks	Magneto shaft bearing hole d	30	1
10	Drill three holes n in crankshaft bearing boss	14-inch vertical drilling machine	Piloted jig plate and special drill head	Crankshaft bearing hole b and one of drilled holes in boss	60	1
11	Drill hole p in crankshaft bearing oil pocket	14-inch vertical drilling machine	Jig plate to hold work vertically	Crankshaft and cam-shaft bearing holes b and c	40	1
12	Drill two No. 12 holes q in magneto shaft bearing boss	14-inch vertical drilling machine	Jig plate	Crankshaft and magneto shaft bearing holes b and d	60	1
13	Tap nine holes g in flange and two No. 12 holes q in magneto shaft bearing boss	No. 2 automatic tapping machine	Quick-change chucks. No fixture used	....	25	1
14	Broach oil groove s in magneto shaft bearing boss	No. 3½ arbor press	Broach	....	40	1
15	Hand-ream magneto shaft bearing hole d	Bench	Vise. Reamer	....	50	1
16	Drill two dowel-pin holes x in flange a	Two-spindle vertical drilling machine	Jig plate	Crankshaft and magneto shaft bearing holes	50	1

TABLE VIII. MACHINING OPERATIONS ON TIMING GEAR-CASE AND COVER—CONTINUED

MACHINING OPERATIONS ON TIMING GEAR-CASE COVER

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Mill face of flange A	No. 5 vertical milling machine	Clamping fixture to hold one casting	Under side of casting	11	2
2	Disk-grind face of flange A	No. 2 disk grinder	....	....	20	1
3	Bore and ream bearing holes for starter-crank shaft C and magneto shaft D	24-inch vertical drilling machine	Quick-change chucks. Two-spindle drill head	Starter-crank shaft bearing boss and inside of magneto gear housing	22	1
4	Drill ten holes E in flange A	Multiple spindle vertical drilling machine	Jig on trunnions to swing over for loading and drilling	Starter-crank shaft bearing hole C and magneto shaft bearing hole D	25	1
5	Drill two No. 12 dowel-pin holes F in flange	Two-spindle 24-inch vertical drilling machine	Drill jig	Magneto shaft bearing D and starter-crank shaft bearing C	50	1
6	Rough- and finish-mill starter-crank support G, spot-face end H and fillet shoulder K	24-inch vertical drilling machine	Quick-change chucks and hollow milling cutters	Pilot on tool enters bearing C	30	1
7	Spot-face surfaces L and M on magneto shaft bearing boss	28-inch vertical drilling machine	Piloted spot-facing tool	Pilot on tool enters bearing hole D	35	1
8	Straddle-mill starter shaft bearing boss N	No. 1½ milling machine	Fixture for holding work vertical	Finished face of flange A	24	1
9	Bore and ream starter shaft bearing O	24-inch vertical drilling machine	Quick-change chucks	Magneto shaft bearing D and starter-crank bearing C	50	1
10	Drill drain hole X for ⅛-inch pipe tap	28-inch vertical drilling machine with tapping attachment	Quick-change chucks and drill jig	Magneto shaft bearing D and a drilled hole E in flange A	60	1
11	Drill two holes P in starter shaft bearing boss N	18-inch vertical drilling machine	Special two-spindle drill head and piloted jig plate	Starter shaft bearing O	60	1
12	Spot-face all holes E in flange	20-inch vertical drilling machine	Spot-facing tool. No. jig used	....	30	1
13	Spot-face clearance Q for end of cam-shaft and chamfer sides L and M of magneto shaft bearing	25-inch vertical drilling machine	No jig	....	60	1
14	Broach oil groove R in magneto shaft bearing	Arbor press	Broach	....	60	1
15	Wash and inspect	Soda kettle	Gages	....	..	..

Machinery

ground steel roll *G* on its lower end. This roll engages a cam plate having a slot of the proper angle to give the required taper to the clutch fit in the flywheel. The cam plate is set over the cross-slide so that the roll will engage with it during the forward motion of the turret slide, thus providing for generating the taper clutch fit with a single-point tool. Two complete sets of turret tools are provided on the machine—one for roughing and the other for finishing—and special tool-blocks are placed at the front and rear of the cut-off slides, which are arranged to act simultaneously with the turret tools. The cross-slide tools face the front and back edges for the rim, and cut the various rounded corners on the rim. This equipment possesses many excellent features of design, and gives an exceptionally high rate of production.

In estimating production on this work, it should be remembered that the speed must not exceed that required for the largest diameter. For this reason, the boring and internal facing operations will really be done at a much slower rate of speed than that which could be used if other tools were not in use at the same time. The largest diameter of the flywheel is about 14¼ inches in the rough state; and as the iron in the castings is of good quality, it would be perfectly safe to assume a cutting speed of 50 feet per minute with a feed of from 0.040 to 0.060 inch per revolution. The length of cut on the tapered inside surface is 2⅜ inches, but as a small amount must be allowed for the sides and ending of the cut, the tool engineer would consider 2½ inches of travel to be necessary. Figuring on this conservative basis, with a feed of 0.040 inch per revolution, the number of revolutions necessary would be $\frac{2.500}{0.040} = 63$. Using a cutting speed of 50 feet per minute, which requires a spindle speed of 13 revolutions per minute, the time needed to make the cut is $\frac{63}{13} = 5$ minutes.

In connection with this operation, it will be noticed by reference to the illustration that a wide tool *D* is used to face the inner surface of the hub, and it naturally follows that this kind of cut must be done with a very fine feed. The amount of stock to remove at this point is assumed to be about 3/32 inch; and it would be an easy matter to arrange the camming of the machine in such a way that a feed of from 0.003 to 0.005 inch per revolution could be used at this time. Always keeping on the safe side in estimating, the tool engineer decides that a feed of 0.003 inch per revolution could be used for taking the facing cut, requiring about 30 revolutions to complete it and occupying 2½ minutes, which, in addition to the 5 minutes consumed in turning, would bring the total cutting time for this operation up to 7½ minutes. The finishing operation, which is performed by the second set of tools, can be done at about the same feeds with a slightly greater speed, say 70 feet per minute, or about 18 revolutions per minute. In taking the finishing cut, the tools would be ground so that a slight drag would be produced in order to leave a smooth finish on the surface of the castings. The time necessary for the finish-turning would be 63÷18 or about 3½ minutes, and the finish-facing of the hub would require simply a smoothing up operation, taking approximately 1 minute. This makes the total machining time for the second operation about 4½ minutes.

The cross-slide tools used in machining the edges of the rim can be used simultaneously with the turning and boring tools, and the time necessary for their work is somewhat less than that required for the work done by the turret tools, so that this need not be considered in estimating. In summing up the time necessary for taking the various cuts included in this operation, we find that the first cut consumed 7½ minutes and the second 4½ minutes, to which we should add about ½ minute for indexing and other movements of the turret and slide, together with about 2½ minutes for setting up and removing the work. This makes a total of 15 minutes for the entire machining operation and corresponds to a production of 4 pieces per hour. This would normally require five machines to give the desired production, but owing to the fact that breakdowns are likely to occur, and to allow for other manufacturing contingencies such as the grinding of tools and replacements, etc., it would be well to include another machine to insure that the production may be kept up to the required amount.

Operation 2, Table VII.—Referring again to the tool and operation list for the flywheel presented in Table VII, it will be seen that Operation 2 consists of counterboring and facing fit *h* for the flange on the crankshaft, and facing surface *j* around the flange fit. It is important for these surfaces to be machined concentric and square with the tapered clutch fit finished in the preceding operation; and so the tapered clutch fit should be used as a locating surface on which to hold the work during the machining operations at the present setting. In order to do this, the holding device which is used must be arranged to draw the work back onto a tapered seat with

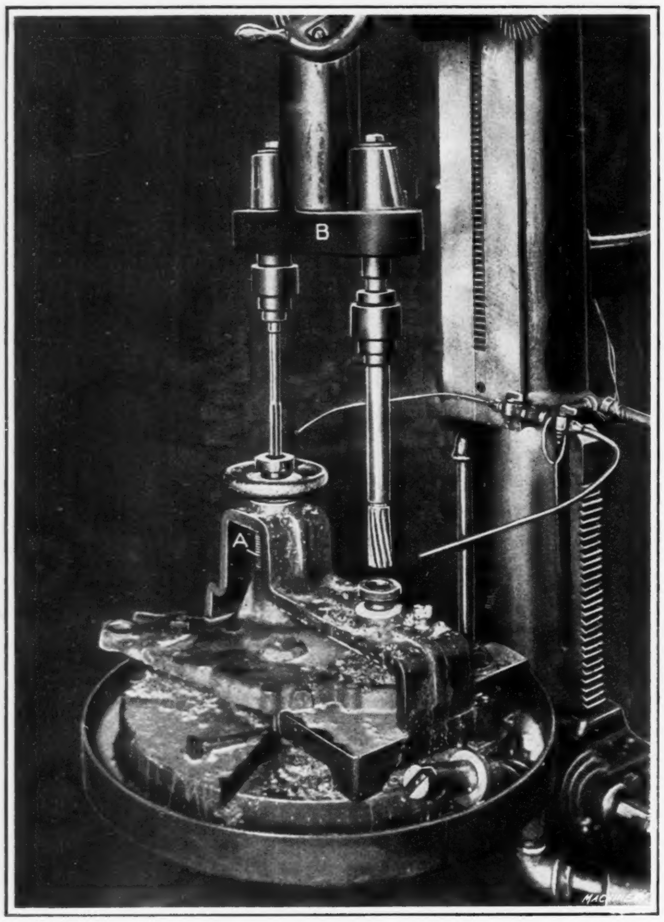


Fig. 19. Cincinnati 24-inch Upright Drill equipped with Sellew Two-spindle Drill Head, Wiard Quick-change Chucks and Tools for boring and reaming Starter-crank Shaft and Magneto Shaft Bearings in Timing Gear-case Covers

a uniform pressure, so that no "cocking" will result. In this instance, the tool engineer decides to use a machine of the turret lathe type, but without automatic features, because the cuts to be made are very short and can be handled to advantage on the regular type of turret lathe.

Fig. 16 illustrates the tool equipment provided for this operation, and the holding device is clearly shown with a flywheel in position on it. This device consists of a special faceplate A, with a tapered seat corresponding to the taper of the clutch fit in the flywheel, and three hooks B for holding the work, which are operated by the large ring C. The design of this device is such that the pressure is equalized on the three hooks, so that the work is drawn back onto the seat with a uniform pressure. On the first face of the turret, there is a disk D that will just enter the flange fit in the flywheel, and in setting up the work, this disk is pushed up against the flywheel to hold it on the faceplate until hooks B have been tightened. The tools used for this operation are piloted into a bushing in the faceplate, and consist of two pairs of tools E and F for roughing and finishing the base of the fit and the narrow flange that surrounds it. The final sizing of the fit is done by a single-point tool G in the fourth face of the turret, which takes a very light cut, this tool being piloted in the bushing like tools E and F. Attention is called to the fact that all the tools used in this operation are conveniently adjustable and are also made so that replacement can be effected with little expense or loss of time. It should also be noticed that the roughing tools are serrated in order to break up the chips and make the cutting action easier. This is an important point in the design of roughing tools that are obliged to encounter scale, as it will frequently happen that a tool of this type used for facing work that presents a smooth surface to the tool will be ruined in a very short time when attacking the scale unless the chip is broken by serrating the cutting edges so that the tool will take hold more easily.

In estimating the time necessary for this operation, the tool engineer is obliged to use his judgment as a guide and do very little figuring, because the cuts are so short that it would not be practical to use power feed on the machine. He would consider the fact that the first or roughing tool would be presented to the work and fed in by the spider wheel until the proper depth had been reached, and he would assume that the operator could bring sufficient pressure to bear on the wheel to approximate a feed of about 0.005 inch per revolution of the work. As the depth of the cut is 3/16 inch plus the finish allowance of, let us say, 3/32 inch, it would be safe to assume that the distance traveled is 9/32 inch or 0.282 inch. The cutting speed permissible for a facing operation of this kind should not be over 50 feet per minute, and the diameter at which the cutting tools are at work is approximately 6 inches. The number of revolutions per minute should be about 32 to give the necessary cutting speed. The number of revolutions required is $\frac{0.282}{0.005} = 56$ (approximately). From this, the time occupied is found to be $\frac{56}{32}$ = a trifle less than 2 minutes.

The second operation performed at this setting is very short, only requiring the operator to bring up the second turret tool and shave off the surfaces until the proper depth has been reached. The tool engineer might safely assume that 30 seconds would be ample for this operation. In the final cut the feed is by hand, as in the previous case, and the operation consists of sizing the flange fit diameter with a single-point tool. The cut is very light in this instance and simply requires that care be used in obtaining a smooth cut, so that 30 seconds would be ample. Allowing 15 seconds for indexing between the various cuts on this piece, and a setting up time of 2 minutes for each piece, the total time consumed for this operation would be 5¼ minutes, which is equivalent to an hourly production of slightly more than 11 pieces. It will be seen that this production is about half what is necessary, and so two machines will be required to do the work. The equipments used on Operations 1 and 2 on this flywheel are excellent examples of the work of the tool engineer in planning methods of machining to obtain the maximum production.

Machining Operations on Flywheel Housing

Operation 1, Table VII.—In order to produce work of this kind to good advantage, it is necessary that in one of the first operations a large surface should be trued up and put

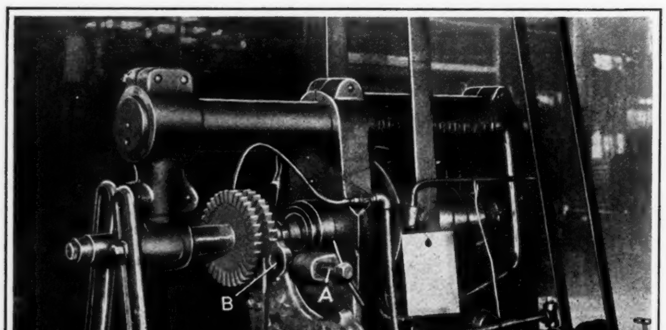


Fig. 20. No. 1½ Cincinnati Milling Machine with Fixture for straddle-milling Starter-shaft Bearing Boss on Timing Gear-case Covers

into condition for use as a locating point. In this particular case, the large flange would form an ideal locating surface for subsequent operations; hence it is well to provide for machining this surface in the first operation. Apparently the most desirable locating point in holding this piece would be the under side of the casting, and the fixture used would contain three fixed points in a triangular formation, together with several adjustable points to form additional supports. Owing to the fact that the only points on which clamps can be placed are the suspension arms and pad for the starter box, additional means of clamping must be used on the side which has no projection. The clamp that appears to be best suited for this purpose is one of the knife-edge swinging type; or the clamp could be made with a pointed set-screw, placed at a slight angle so it will draw the work down onto the fixture. This point could be left to the judgment of the tool designer when laying out the fixture, as there would be no particular choice between the two methods of clamping except in regard to the rapidity of operation.

When deciding upon the type of machine for doing this work, the tool engineer reaches the conclusion that a heavy vertical milling machine having a large cutter to extend over somewhat more than half the piece would give the best results, two cuts being necessary to complete the facing operation. In this case a cutter having a diameter of about 10 inches would be sufficient to cover a little more than half the casting at each cut. The problem of machining this particular casting requires no special attention, except that the method of holding must be very rigid so that chatter will not be produced by the cutter acting against an unsupported surface and causing vibration.

Operation 5, Table VII.—This operation consists of straddle-milling suspension arms *F*. In considering the method of locating and the surfaces from which to hold the work for this operation, the tool engineer decides that one of the locating surfaces must be the finished edge of the transmission flange; and the other important locating points must be the surfaces of the bosses to be milled. The tool engineer decides that a good machine to use for this work is a horizontal milling machine having a table of sufficient length to carry two of the castings at a time. His idea is that the work can be produced very rapidly by using a fixture holding

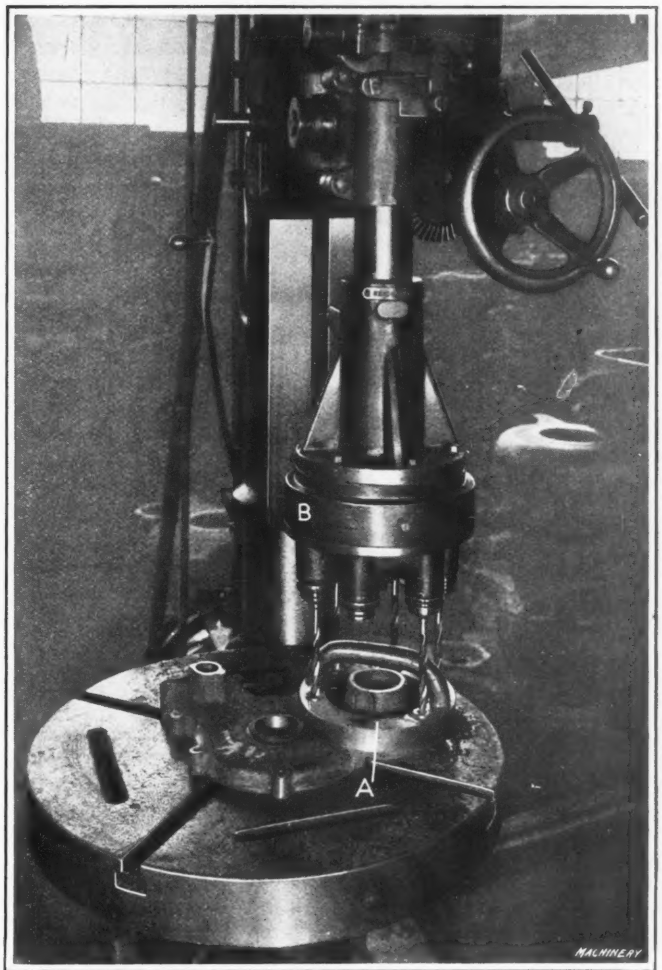


Fig. 22. Cincinnati 24-inch Upright Drill and Sellew Six-spindle Drill Head for drilling Five Holes in Front Crankshaft Bearing on Timing Gear-cases

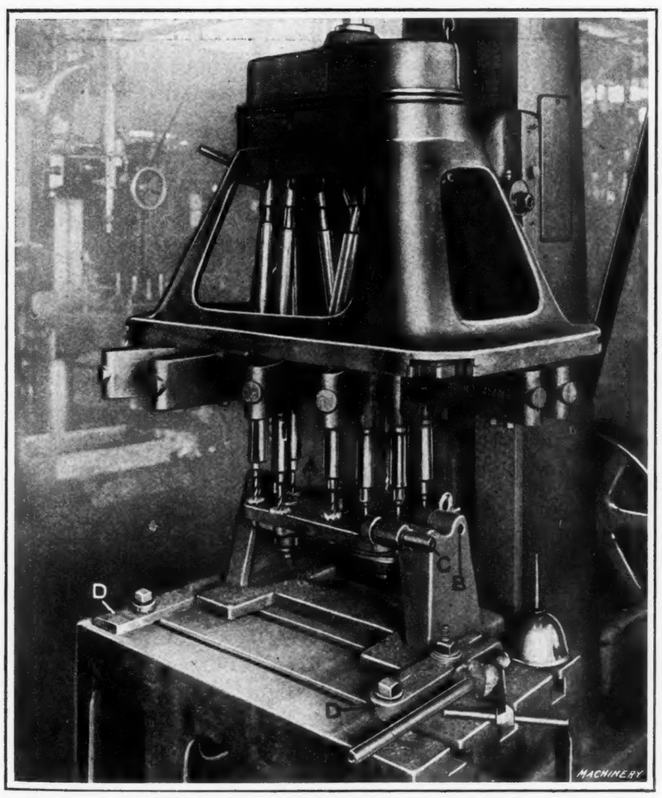


Fig. 21. Baush Multiple-spindle Drill equipped for drilling Ten Holes in Flange of Timing Gear-cases—Note Means for turning over Jig Plate and sliding Entire Fixture out from under Spindles for loading

two pieces and working from one to the other. In planning this operation, the tool engineer first considers that the suspension arm at each end of the casting must be machined, and that the locating point in milling one of the suspension arm bosses must be the rough surface of the boss on the opposite arm, while in milling the second boss the locating surface must be the previously milled surface of the first boss. The combination fixture is shown in Fig. 17, and this illustration indicates the method which the tool engineer developed for doing this particular piece of work. It will be seen that on the right-hand end of the table, the fixture is so arranged that the rough surfaces of the boss *A* farthest from the cutter are held by the locating clamps, and these clamps are operated by a handwheel conveniently placed. The fixture at the other end is arranged with a slot cut in a lug *B*, into which the finished boss is dropped to locate the work for taking the cut on boss *C* on the suspension arm at the other end of the flywheel housing.

The work is clamped down on both fixtures by means of a central stud and collar which draw the castings down against the finished face of the flange. The suspension arm bosses on which the cut is taken are supported by means of plungers operated by two handwheels that will be seen on the fixture near the cutters. Attention is called to the fact that the cutter is working downward against the boss on the right, while in making the cut on the left the action of the cutter tends to lift the work. A cut of this kind might easily cause chatter unless suitable provision were made to guard against it in the design of the fixture. This point has been very well taken care of in the present instance by means of handwheels which operate the supporting pins previously mentioned, and by a supplementary clamp *D* on the left, which draws the work down and holds it securely against the lifting action of the cutter so that there is no possibility of spring under the pressure of the cut.

The procedure in milling this piece is as follows: The

operator first takes the casting, places it on the right-hand side of the fixture and machines the first boss as shown in the illustration. He then removes the casting and places it on the section of the fixture at the left, locating the finished boss in the slot in lug *B*. The movement of the table is now reversed and the milling cutter works on the boss on the suspension arm at the opposite end of the flywheel housing. While this is being done, the operator puts a new casting on the right-hand end of the fixture which is free to receive it, and is just about able to set up this piece in place by the time the milling cutter is ready to start working on it. Then the table is again moved over so that the cutters attack the new piece and this procedure is repeated on all the work so that the operation of milling is almost continuous.

In estimating production, the tool engineer decides that he will use a cutter 6 inches in diameter on which he assumes a cutting speed of 60 feet per minute, because of the open nature of the work and the comparatively small amount of surface covered in the machining. A fairly good finish is desired on the bosses, and for this reason a comparatively fine feed would naturally be used. The length of surface to be covered by the cut is a trifle over 2 inches; and the length which it would be safe to use for estimating purposes might be called 2¼ inches. The 6-inch cutter revolving at 40 revolutions per minute would produce a cutting speed of 60 feet per minute, and a feed of 0.040 inch per revolution of the cutter would produce a finish of about the quality desired on the bosses. As the cut is 2.250 inches in length and the feed 0.040 inch per revolution, the number of revolutions that would be necessary to make this cut on one end of the suspension arm would be $\frac{2.250}{0.040} = 56$ revolutions which, divided by 40 revolutions per minute, would give approximately 1¼ minute as the time required for the operation.

The piece at the other end of the table can now be brought into contact with the cutters and machined in a similar manner. The same amount of time would be necessary for this cut as for the previous one, making 2½ minutes for the double cut. While one cut is being taken, the operator removes the piece just finished, and during the entire progress of the work one piece is being removed from the fixture during every cutting operation, so that in figuring production it is only necessary to consider the entire cutting time for two bosses, which in this instance would be 2½ minutes, which would give a production of 24 pieces per hour. It will be seen that this production leaves no time for the operator to attend to such matters as the removal of a set of cutters from the arbor and their replacement by a new set, or for other contingencies frequently met with in manufacturing. For this reason it would be safer to assume that the production would be about 22 instead of 24 pieces per hour. In any case, one machine would be sufficient to give the necessary production on the flywheel housing.

Operation 7, Table VII.—This operation consists of boring, reaming and chamfering hole *H* for the self-starter box bearing. In deciding on the locating points for this operation, the relation of the starting shaft hole to the center of the crankshaft bearing must be considered, and knowing that this relation must be kept to an exact limit, the tool engineer decides that the locating must be done from the finished center hole in the flywheel housing. The location of the hole to be machined must also bear a definite relation to faces on the suspension arms which have been milled in the previous operation, and so these faces must also form one of the points from which the location must be determined. The surface of the large flange on the casting makes an ideal support for the work during this operation, and the tool engineer is careful in instructing his designer to relieve the supporting surfaces so that a small amount of contact will minimize the chance for chips accumulating on the locating surface. Reference to Fig. 18 will show the general construction of the jig. Attention is called to the method of locating the two suspension arm surfaces by means of cam-operated plungers *A*. The cams *B* on each side of the fixture are operated simultaneously by means of the horizontal link *C* which extends across to connect with a short lever on the lower end of each cam. Both the plungers are carried forward the same amount until they meet the milled surfaces on the bosses. As a center location in the casting is essential, it is necessary to make these two points which bear against the suspension arms in such a way that they will be drawn back out of the way while placing the casting in position. The work can then be slipped onto the central stud and positively located by operating the lever which controls the cam-actuated plungers *A* that engage the pads on the suspension arms. After this, the clamps are tightened and the work is ready for machining. The tools used for this operation are a core drill, counterbore, and reamer, which may be seen in Fig. 18. Slip bushings are provided for the four-lip drill and also for the reamer, but the countersink is used in the open hole without any bushing, because it only takes a light cut.

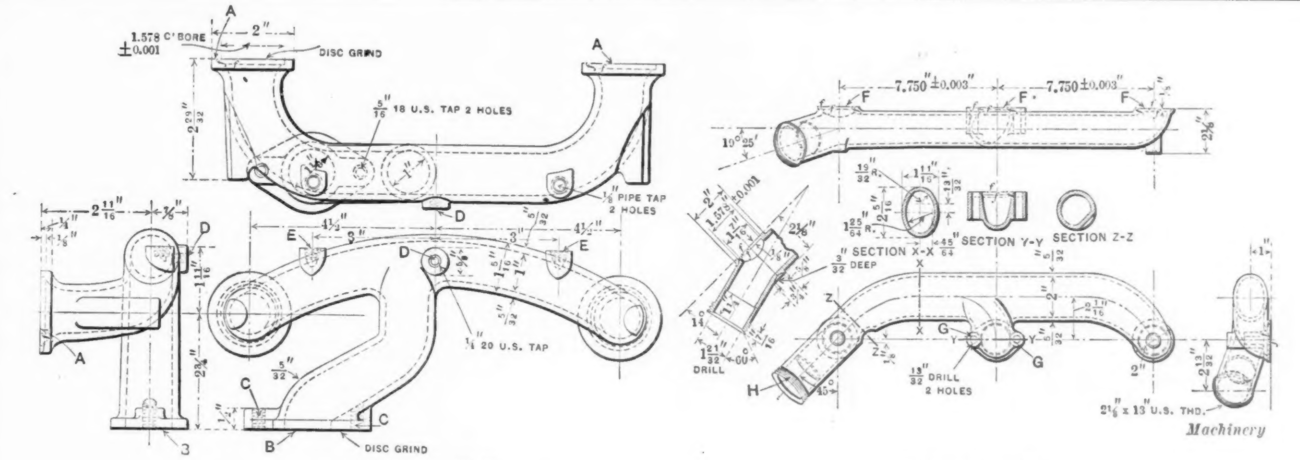
In estimating the production on this work, sufficient time must be allowed for changing the various tools and slip bushings. To facilitate the exchange of tools, the spindle is fitted with a quick-change type of chuck. The diameter of the hole to be bored is 2¼ inches and the thickness of the web through which it passes is 1/4 inch. A cutting speed of 50 feet per minute would require the core drill to run at about 90 revolutions per minute; and a feed of 0.020 inch per revolution would be feasible for use in taking this cut. It would be safe to assume that the total distance through which the drill passes will not be over 1/2 inch, including the chamfer on the end of the drill, so that the number of revolutions necessary to complete the cut would be $\frac{0.50}{0.020} = 25$, which is equivalent to about 17 seconds. The chamfering operation would simply require the tool to be lowered into the hole and given a slight movement with the feed lever to "break" the sharp edge of the hole, the estimated time for this operation being 10 seconds. The reaming cut in cast iron could also be done by hand in a very short time, the estimate being about 10 seconds. Allowing 10 seconds for each interchange of tools during this series of operations, 10 seconds for each removal and replacement of bushings and 40 seconds for setting up and removing the work, we would have as a total a little over 2 minutes for each piece. A certain amount of time should also be added to this for the movement of the spindle and the cleaning out of the jig from time to time, so that it would seem to be safe to give a production of 2½ minutes or 24 pieces per hour on the machine. Under these conditions it would be found that one machine is sufficient to give the necessary production.

Machining Operations on Timing Gear-case Cover

Operation 1, Table VIII.—In studying the design of this piece, it would be apparent that the first operation should consist of taking a milling cut across the face of the flange *A*, to provide a locating point for subsequent operations; and the question will immediately arise as to whether the piece could be held securely during this milling operation. In looking over the outline it will be seen that the arm containing bearing *O* could be used for holding down one portion and that knife-edge clamps could be applied below the milled surface at other points around the contour. As this operation is the only one that would be likely to cause difficulty in clamping, the conclusion would at once be reached that the casting could be used in the condition shown without the necessity of employing any additional holding lugs. In determining the point from which to start the work, the irregular face *A* of the flange is selected because it is the only continuous machined surface of any size on the piece. As the piece is of cast iron and the flange of irregular shape, it is evident that it can be machined to good advantage with a large inserted-tooth mill mounted on a vertical milling machine.

Operation 3, Table VIII.—The logical way to decide upon the next operation (after flange *A* has been milled and ground) is to note that there are two holes in the piece which act as bearings and that the location of these holes in relation to each other is important. In addition, it must be

TABLE IX. MACHINING OPERATIONS ON INTAKE AND EXHAUST MANIFOLDS



Intake Manifold

Exhaust Manifold

MACHINING OPERATIONS ON INTAKE MANIFOLD—MATERIAL, ALUMINUM

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Disk-grind port flanges A and carbureter flange B	No. 2 disk grinder	....	....	50	1
2	Counterbore intake ports A	21-inch vertical drilling machine	Adjustable V-block fixture	Outside of ends of pipe	60	1
3	Drill two holes C in carbureter flange. Drill hole D in side of manifold	18-inch two-spindle vertical drilling machine	Jig with bushings in three sides. Two-spindle drill head	Finished flanges and carbureter port B	50	1
4	Drill two holes E	18-inch two-spindle vertical drilling machine	Same jig as that used for Operation 3	Finished flanges	50	1
5	Tap holes C, D and E	No. 2 automatic tapping machine	Quick-change chucks. Same jig as for Operations 3 and 4	Finished flanges	20	1

MACHINING OPERATIONS ON EXHAUST MANIFOLD—MATERIAL, CAST IRON

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Grind faces of flanges F	No. 2 disk grinder	....	....	90	1
2	Counterbore ports F	28-inch vertical drilling machine	Special three-spindle drill head. V-block fixture	Outside of pipe	60	1
3	Drill two holes G in center flange F	24-inch vertical drilling machine	Special two-spindle drill head. Fixture with pilots to enter ports F	Counterbored ports F	60	1
4	Bore, countersink, hollow-mill and thread end H	28-inch vertical drilling machine	Quick-change chucks. Opening die	Counterbored ports F	20	1
5	Air test at pressure of 60 pounds per square inch	Special testing machine	Pressure gages	....	..	..

borne in mind that the shafts which pass through these holes carry gears, and these gears must have clearance inside the case. The surface of flange *A* which has been previously milled and ground to a nice finish should be used as a primary locating surface on which to rest the piece, while the rough surface of the casting inside of the gear-case near bearing *D* should be used for the secondary locating point in a horizontal direction. Suitable pins or studs can be easily arranged in the fixture so that the work can be quickly located against them. A third point of location is provided by a bell-mouthed bushing that screws down onto the top of the boss surrounding the starter-crank shaft bearing *C*. This is clearly shown at *A* in Fig. 19. In this case, clamping the work would present no difficulty whatever, as the piece rests on a finished surface and the clamps can be conveniently placed around the outline of the casting. The type of machine upon which the work is to be done must now be decided upon, and this would ordinarily call for the use of a two-spindle drilling machine with adjustable spindles; or an upright single-spindle drilling machine having sufficient power to pull two drills of the required size could be used, equipped with a drill head made up to give the correct center distance between the drill spindles. The tool engineer decides to use a 24-inch vertical drilling machine for the reason that there are more of these machines in the factory than the other type of machine, and the special drill head *B* can be made up without difficulty. The fixture will be made in such a way that the bushings are of the slip type, with the exception of the screw bushing *A*, Fig. 19. This brings up another point in the design of the tools, which is the removal of the drills and their replacement by reamers during the process of the work. An opportunity is here given for the tool engineer to make use of a quick-change type of drill chuck, which allows the drills to be quickly replaced by the reamers and *vice versa*.

In figuring production, it must be remembered that two tools are used in each hole, *viz.*, a four-lipped core drill and a finishing reamer. The depth of the longest hole is 1¾ inch, which, considering the rough state of the casting and the angular point of the drill, may be considered as a 2-inch run for the drill. A cutting speed of 50 feet per minute can be safely assumed for this material, and as the largest hole is a trifle over 1 inch in diameter, the speed must be 200 revolutions per minute. A feed of 0.020 inch per revolution could be employed were it not for the fact that simultaneously with this drilling of the cored hole the smaller hole must be drilled from the solid, which would require the use of a twist drill and a feed of 0.007 inch per revolution. As these two tools are working at the same time it would, of course, be necessary to make the feed of both drills the same as that required for the small hole, *i. e.*, 0.007 inch per revolution.

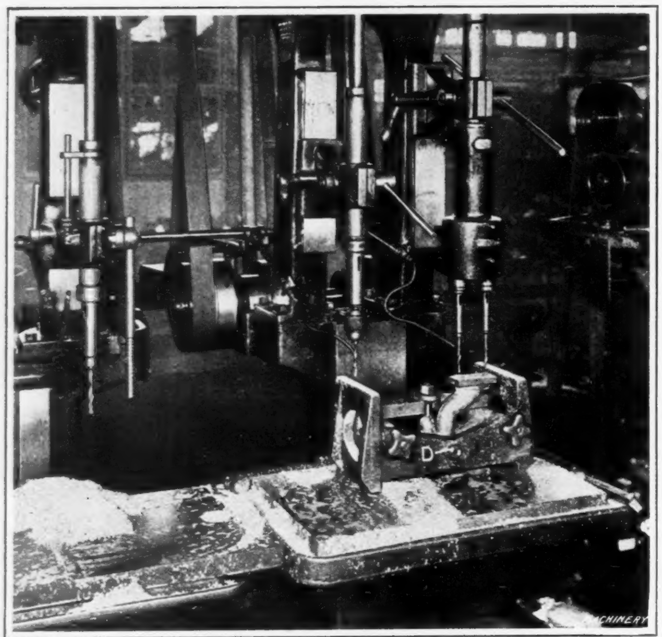


Fig. 23. "Avey" Two-spindle Drill Presses and Sellew Drill Head for drilling All Holes in Intake Manifolds without requiring Work to be reset in Fixture

The long hole would require $\frac{2}{0.007} = 286$ revolutions to complete the drilling operation. Then, $\frac{286}{200} =$ approximately $1\frac{1}{2}$ minute, which is the time required for performing the operation. In preparing for the reaming operation, it is necessary to change the tools in both spindles, and for this purpose quick-change chucks are employed so that the work can be done rapidly. The tool engineer allows 15 seconds for making the change of tools, 20 seconds for performing the reaming operation, and 40 second for setting up and removing the work. This brings the total time necessary for one complete operation up to 2 minutes, 45 seconds, which gives a production of about 22 pieces per hour.

Operation 8, Table VIII.—The tool engineer has as yet made no provision for machining surfaces *N* on each side of the starter shaft bearing *O*, and it would be well to machine these surfaces at this time in order to provide an accurate machined surface against which the drilling may be done. Consequently, it would seem advisable to straddle-mill this boss, using the finished surface *A* of the flange as a locating point, so that the relation between the finished inner side of the boss and the flange will be uniform. In order to hold the piece in such a way that the boss will be in the correct relation to the cutter, it is necessary to build the fixture so that the piece will stand up almost on end, having the starter shaft bearing boss at the top. The design of the fixture presents no particular difficulty except that it must be built very substantially on account of its height, so that no chatter will be produced by the cut. The milling cut taken at this time is not particularly heavy; hence a No. $1\frac{1}{2}$ milling machine is selected for doing the work, as the power required is not excessive. This fixture is shown in Fig. 20. It will be seen that a backing-up screw *A* is placed directly behind boss *B* which is being faced on both sides, so that the work will be adequately supported against the cut, and thereby chatter will be prevented.

In figuring the production on this piece, it can be safely assumed that the cutting speed at which the work should be done is 50 feet per minute, because the material is cast iron; and as the cutter is 6 inches in diameter it would require 34 revolutions per minute to obtain this cutting speed. The travel of the table must be about $2\frac{1}{4}$ inches in order to complete the milling operation; and a feed of 0.040 inch per revolution would be about right for this operation, owing to the fact that the work stands very high above the table and the feed cannot be heavy. The number of revolutions necessary to complete the cut will be $\frac{2.250}{0.040} = 56$, and as the cutter is revolving at the rate of 34 revolutions per minute, 1 minute, 40 seconds is required. Allowing about 45 seconds for setting up and removing the work, and 5 seconds for returning the table to its position after making the cut, the total time consumed would be $2\frac{1}{2}$ minutes, giving a production of 24 pieces per hour. Consequently, one machine only need be used.

Machining Operations on Front Bearing and Gear-case

Operation 1, Table VIII.—Referring to Table VIII, it will be seen that the first operation on this piece consists of milling the face of the flange *a*, and in considering this operation, the tool engineer first determines the point from which the work should be located. He considers that it is advisable to mill the face of the flange in the first operation so that a reliable surface can be obtained for locating the work in subsequent operations. As the casting is in the rough, it must be supported on three points which are fixed, and other adjustable supports must be provided to hold the work under the points where the milling operation is taking place. In general construction, a fixture for this purpose will be designed on somewhat the same lines as that used for the gear-case cover, so a detailed discussion of the matter is unnecessary.

Operation 5, Table VIII.—This operation consists of drilling ten $\frac{3}{8}$-inch holes *g* in the flange. In determining the method of locating the work, the tool engineer considers the fact that the holes in the flange which are to be drilled in this operation should be located in a certain fixed relation to the magneto-shaft, cam-shaft, and crankshaft centers. But as it is not practical to arrange a fixture with studs for each of these three points, the crankshaft and magneto-shaft bearing holes *b* and *d* are selected because they are the farthest apart. In addition to these points, the previously milled surface of the flange would naturally be the surface on which the work should be clamped. Having selected the locating points, the tool engineer would next consider the machine to be used, and in this case a multiple spindle drilling machine would naturally be selected.

As previously mentioned, the logical way in which to hold the work would be to locate it on two studs and clamp it against the finished surface of a jig plate in which the drill bushings would be mounted. But, as the drilling should be

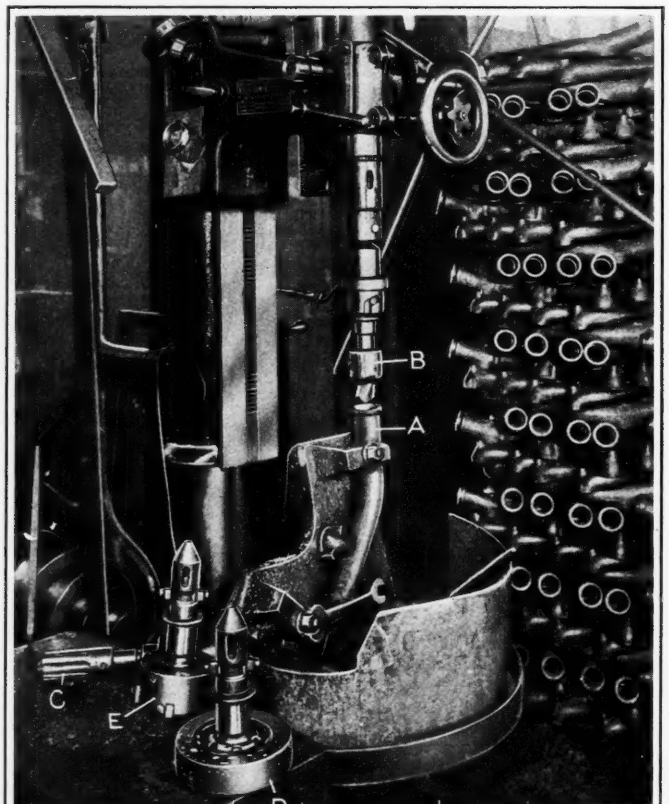


Fig. 24. "Aurora" 28-inch Upright Drill equipped with "Wizard" Quick-change Chuck and Tools for drilling, countersinking, hollow-milling and threading End of Exhaust Manifolds

done from the side toward the finished surface of the work, it is apparent that it would be rather awkward for an operator to place the piece in position on the fixture, because it would have to be held on the under side of the jig plate. The operator would be obliged to lift the piece up into position, and hold it there during the clamping operation. In order to avoid this difficulty, the tool engineer decides to make the fixture as shown in Fig. 21, mounting the jig plate *A* on trunnions *B* so that in loading, the work can be placed directly on top of the jig plate and clamped in position, being afterward revolved to the position shown and located by the knurled pin *C*. Furthermore, it would be rather difficult to set up the work on the fixture while it is directly under the spindles, and so straps *D* are placed on the drilling machine table, which act as guides for pulling out the jig from under the spindles and pushing it back again. In this way the operator can load the fixture without difficulty, and a suitably arranged stop can be provided so that it can be pushed into the proper position with little trouble.

In figuring production on this piece, it must be remembered that the drilling operation takes place against the clamps and, furthermore, that there are ten drills acting simultaneously so that the accumulated pressure exerted is considerable. Reference to the view of the work shown at the upper left-hand portion of Table VIII will show that nine holes are drilled with a 3/8-inch tap drill and one with a 13/32-inch drill. The cutting speed can be safely assumed to be 50 feet per minute, which for drills of this size would be equivalent to 440 revolutions per minute. In order to minimize the effect of the pressure of the cut in drilling, the tool engineer decides that a feed of 0.005 inch per revolution will be about all that can safely be used. The total length of the drilled hole is 1.500 inch, which divided by the feed would give $\frac{1.500}{0.005} = 300$ revolutions or approximately 45 seconds as the time occupied by the drilling operation. Allowing in addition to this, say 15 seconds for the raising and lowering of the drill head, and 1 minute for setting up and removing the work, the total time will be 2 minutes for each piece, which is equivalent to a production of 30 pieces per hour.

Operation 6, Table VIII.—This operation consists of drilling five 13/32-inch holes *h* in the front crankshaft bearing flange. In locating the work in the drill jig, the turned crankshaft bearing boss *e* is selected by the tool engineer for the reason that the position of the holes to be drilled must bear a definite relation to the surface of this boss. It is feasible to rest the work on the finished surface of flange *a*, and to use a plate type of jig *A*, Fig. 22, that can be dropped over flange *e* and that has a dowel-pin which enters one of the previously drilled holes, thus making the location both positive and simple. In order to facilitate handling the jig, a generous sized handle is attached in a convenient place, as shown in Fig. 22. A special type of drill head *B* having spindle distances correctly spaced to do this work is used for the drilling operation. The machine is a 24-inch vertical drilling machine, to which the drill head may be attached without difficulty.

In figuring production on this operation, the cutting speed can be assumed to be 50 feet per minute, making the speed at which the drills must be rotated approximately 440 revolutions per minute. In this particular case a little more feed can be used on the drills than in the previous operation because the work is more firmly supported and there is no danger of springing it. Under these conditions the tool engineer might assume that the feed can be 0.007 inch per revolution, while the distance which the drill must travel is about 5/8 inch. Hence, $\frac{0.625}{0.007} = 89$ revolutions to complete the drilling; and this means that the drilling time would be somewhat less than 1/4 minute. Allowing 45 seconds for setting up the work and for the various movements of the spindle, production could safely be figured at 1 minute for each piece or 60 pieces per hour. This is very conservative, and as a matter of fact considerably over this number of pieces could readily be produced.

Machining Operations on Intake Manifold

Operation 1, Table IX.—The first operation on this piece consists of disk-grinding port flanges *A* and carbureter flange *B*, the principal requirements being that these surfaces should be smooth and free from tool marks. For this reason the disk-grinding process is selected by the tool engineer as being most suited to this class of work. The material of which the intake pipe is composed is aluminum, which is easily cut and can be polished to a highly finished surface.

Operations 3 and 4, Table IX.—Operation 3 consists of drilling two holes *C* in the carbureter flange, and drilling hole *D* in the side of the manifold. Operation 4 consists of drilling the two 1/4-inch holes *E* in the side of the pipe. The tool engineer, in planning the work on the intake manifold, decides that these two operations can be profitably combined by designing a suitable drill jig and making use of some of the multiple spindle drilling machines which are included in the factory's machine tool equipment. The logical place from which to locate the work for these drilling operations is the finished end flanges and the carbureter flange. In order to handle this work to the best advantage, the drill jig is made in such a way that all the holes in the two operations mentioned can be drilled without removing the piece from the jig, by simply turning it over on its sides. In order to obtain high production, a special drill head, having spindles properly placed for spacing holes *C* in the carbureter flange, is used for this part of the drilling, as shown in Fig. 23. It will be seen that the second spindle on the machine can be used for drilling hole *D* in the side of the pipe by merely turning the jig over on one side. After this hole has been drilled, the position of the jig is reversed and it is then slid over onto the table of the next drilling machine. One spindle on this machine is shown at the left of Fig. 23. The machine has two spindles which are so placed that the correct spacing for the two holes *E* is insured, and as the holes may be drilled simultaneously a high production is obtained.

In estimating production on these two operations, it is safe to consider that the cutting speed for aluminum is from 400 to 600 feet per minute, 400 being conservative while 600 is high production. In all of the drilling operations on the intake manifold, the spindles are hand-operated and the speeds are so high that the time necessary to do the actual drilling is very small indeed. For example, in drilling the carbureter flange holes the drill diameter is 13/32 inch, which at a cutting speed of 400 feet per minute would require that the drill be run at a speed of 3500 revolutions per minute. It can easily be seen that if a depth of about 1 inch is required, such as that in the flange hole, and if the feed is assumed to be about 0.005 inch per revolution, then $\frac{1.000}{0.005} = 200$ revolutions which, at a speed of 3500 revolutions per minute, means that the length of time necessary to perform this operation would be about 3½ seconds. Allowing about 3½ seconds for each of the two other drilling operations, would bring the total amount of time for machining up to about 10 seconds. Allowing ¾ minute for setting up and removing the piece and 15 seconds for the incidental movements connected with turning the jig on its side and moving it from spindle to spindle, the total time for the operation on this piece would be 1 minute, 10 seconds, which would give an hourly production of slightly over 50 pieces or about double the amount required. Two machines used as indicated will both be required, although their time will not be fully occupied, so that they could be used for other operations if convenient.

Machining Operations on Exhaust Manifold

Operation 1, Table IX.—This operation is performed in the same manner as the first operation on the intake manifold, *i. e.*, by disk-grinding the faces of flanges *F*.

Operation 4, Table IX.—This operation consists of boring, countersinking, hollow-milling and threading end *H*. Previous to this operation, the counterbored holes *G* in the flanges *F* have been machined, and so these holes can be used with the finished faces of the flanges as locating points for the operation now to be performed. The next point to be decided in

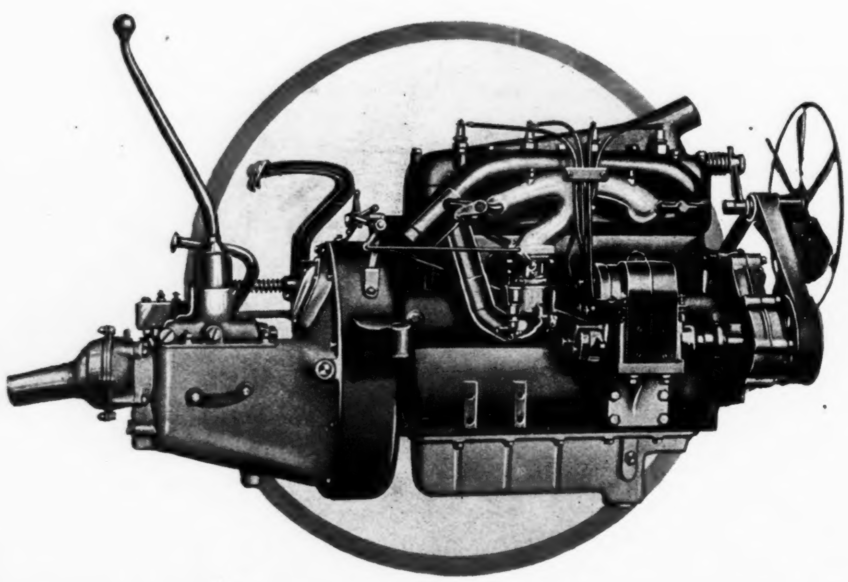
regard to this operation is the type of machine on which the work should be done. In this case, the casting is of such a shape that it seems advisable to stand it up on end in a fixture that will simply act as a holding device. Fig. 24 shows an illustration of the fixture with the work *A* in position, and the various tools are shown either in the spindle or on the table beside the machine. In order to make the exchange of tools used in machining this end of the exhaust manifold, quick-change chucks are utilized so that there will be a minimum loss of time. A 28-inch vertical drilling machine is selected as being most suitable for this operation, both on account of the cost of the machine and convenience in operating.

In estimating production, the tool engineer considers that the cutting speed for all operations except threading should be about 50 feet per minute, and as the diameter of the work at this point is 2 inches, the cutting tools should revolve at 100 revolutions per minute. The tools comprise a combined chucking or four-lip drill and countersink *B* which is shown in the spindle in Fig. 24, a reamer *C*, a hollow-mill *D*, and a die-head *E* which is of the opening type. These tools are used in the sequence mentioned, the length of time necessary for each cutting operation being estimated herewith. The combined four-lip drill and countersink running at 100 revolutions per minute is fed into the hole at a feed of 0.015 inch per revolution to a depth of 1¼ inch. As a matter of fact, the tool engineer would figure as if the depth of cut were about 1½ inch, in order to take care of variations in the length of the casting and also of the countersinking operation. The number of revolutions necessary for this operation would be $\frac{1.500}{0.015} = 100$, which is equivalent to 1 minute. In addition to this, the countersink would be fed in by hand to the proper depth, taking from 5 to 10 seconds, which makes the total time 1 minute, 10 seconds. The reamer is next inserted and the machine slowed down to about 50 revolutions per minute, after which the reamer is fed into the work by hand. An allowance of about 15 seconds would be made for this operation. The hollow-mill is now placed in the spindle and the speed changed to 100 revolutions per minute with a feed of 0.020 inch per revolution. The length of cut here is about 1/2 inch plus, say, 1/8 inch for variation, making 5/8 inch in all. The number of revolutions necessary for completing this cut would be $\frac{0.625}{0.020} = 31$, which is equivalent to 20 seconds.

The threading operation is now performed with the opening die-head *E*, and the speed of the spindle is slowed down to produce a cutting speed of about 20 feet per minute, which on this diameter would require 40 revolutions per minute of the spindle. As the pitch of the thread is 13 per inch, and as we have considered that a length of about 5/8 inch is necessary, it would require about 10 revolutions of the die-head to produce the thread. The time necessary to do this portion of the work would be 15 seconds. During the process of this work, it is necessary to change the tools four times and some of the tools are somewhat heavier and more difficult to handle than others. An average allowance of perhaps 10 seconds for each change would call for 40 seconds for all the changes, which should be ample. In addition to this, an allowance of 40 seconds must be made for setting and removing the work and 20 seconds for the movement of the spindle up or down preparatory and subsequent to the cutting operation. Consequently, the total time necessary for producing one piece in this operation would be 3 minutes, 40 seconds. As this time, however, could be cut down by an operator after he has become thoroughly familiar with the work, and as the time allowances are very generous and the cutting speeds conservative, the tool engineer estimates that one machine will be sufficient to give the required production of 20 pieces per hour.

Conclusion

The information in this article comes under three main heads: First, the procedure in planning the best order in which to perform machining operations; second, the conditions which govern the design of jigs, fixtures and special tools to obtain a high degree of efficiency in manufacture; and third, the principles which govern the estimation of production on any machining operation, after the equipment for that operation has been designed but before it has been made. For the purpose of discussion, certain important parts of an automobile engine were selected and the method of procedure followed in preparing for the manufacture of these parts was explained in detail. This was a natural course to follow because the scientific planning of operations and designing of all equipment required to obtain a given rate of production has been carried further in the automobile industry than in most other lines of manufacture. But in case the fact has not already been grasped by the reader, attention is called to the fact that although this article concerns itself with the manufacture of certain automobile engine parts, all of the principles described are general in their application and can be used by men who are called upon to devise methods and design equipment for use in the manufacture of many other classes of interchangeable parts.



RECENT LEGAL DECISIONS INVOLVING MACHINERY

Claim for Breach of Warranty Disallowed

(Kansas) The plaintiffs assisted a machinery company in selling an engine to one of the defendants, for which he gave notes to the sum of $2305. The plaintiffs guaranteed the machinery to work satisfactorily, and purchased the notes given to the vendor. The engine proved defective and the purchaser made repeated complaints, and, after certain efforts by the plaintiffs to adjust it, they advised the purchaser to see what he could do with it by giving it further use. Long after this, with their consent, he traded the engine toward a new one and took up the old notes with the ones sued on, which he secured by a mortgage covering the new engine. This was some two years after the execution of the original notes, and when giving the new notes he was told by the plaintiffs that he would finally be allowed for the time he had lain idle with the old engine. In an action on the notes last given, he sought to recoup damages for breach of warranty of the old engine, claiming that he was forced to expend $1400 for the hire and rent of an engine for the time when the engine purchased was not working.

The court refused to allow defendant's claim for damages on the theory that his giving the new notes two years after the original engine had been delivered operated as a case of acquiescence and estoppel. The court could not understand why any damages agreed upon between the parties were not deducted at the time of executing the second notes. *(Muenzenmayer v. Hood, 155 Pac. 918.)*

Selection of Dangerous Way of Handling Machinery

(Pennsylvania) Where an experienced operator of a defective machine for punching holes in steel boxes took hold of the bottom of a box to remove same, thereby placing his hand under the die, though there was a safer way of which he knew to remove the box by taking hold of the side, he was guilty of contributory negligence, precluding recovery for injuries caused by the unexpected repeating of the machine. *(Fritchle v. Steel City Electric Co., 96 A. 1083.)*

Cannot Recover Cost of Making Tests

(New York) Where a contract for the equipping of a pier with machinery provided that, when the equipment was sufficiently completed to require the occupation of the electric generating plant, the contractor should furnish a competent crew to operate the plant for the period of six days, during which time proper tests should be made, the contractor could not recover from the city for coal and labor used in operating the plant to make the tests. *(N. E. Const. Co. v. City of New York, 112 N. E. 53.)*

Machinery Not Covered by Lien

(Kansas) Machinery purchased for use in a mill, intended to be permanently fastened in place by bolts, does not ordinarily become a part of the realty until the physical attachment is accomplished. And where such machinery is sold under a contract reserving title in the vendor until payment is made, it does not become subject to a mechanic's lien, notwithstanding the fact that the contract is not recorded until after the lien has accrued and the machinery has been deposited in the building, provided such record is made before it is set up and fastened in place. Such was the holding in St. Mary's Machine Co. v. Iola Mill & Elevator Co., Kansas Supreme Court.

The St. Mary's Machine Co. sold two gas engines to the Iola Mill & Elevator Co., under a written contract providing that title should remain in the vendor until the purchase price was paid. Payment was not made, and the seller brought replevin for the engines, which, in the meantime, had been set up and bolted to concrete bases in a building erected by the buyer. Caroline Frantz, who by a sheriff's deed had acquired title to the building, intervened and claimed the engines as a part of the real estate. The plaintiff recovered and Caroline Frantz appealed to the Supreme Court, where the judgment was affirmed. *(St. Mary's Machine Co. v. Iola Mill & Elevator Co., 155 Pac. 1076.)*

Recovery of Price of Machinery

(Kentucky) Where a contract of sale of machinery merely permits the buyer to return it if it is not as warranted, and does not provide that it shall be deemed to fulfill the warranty unless returned, he may, though it does not satisfy the warranty, retain it, and recoup his damages for the breach, in an action by the seller for the price. Unless machinery sold is absolutely worthless for every purpose, though it is useless to the buyer, he must return it, or offer to return it, before he can recover the price. *(Hauss v. Surran, 182 S. W. 927.)*

"Simple Tools"

(Kentucky) It is interesting to know that our courts have arrived at a definition of such tools as are known as "common" or "simple" tools. Justice Turner of Kentucky in Hoskins v. Louisville & N. R. Co. says that "simple" tools are such tools as are so simple in their nature that any one of ordinary intelligence may safely use them without any instruction or assistance. The court went on to say that an employer is not bound to inspect such tools before putting them at the disposal of a servant for use in work. If they are used by a servant who is injured by their defective condition, the case is clearly one of contributory negligence on such servant's part. *(Hoskins v. Louisville & Nashville R. Co., 181 S. W. 352.)*

Trademark

(New York) Justice Weeks of the New York Supreme Court defines a "trademark" to be one's commercial signature, a word, symbol, or device by which the wares of the owner are known in trade. *(Star Co. v. Wheeler Syndicate, Inc., 155 N. Y. S. 782.)*

* * *

RECOVERING OIL FROM WASTE

It is interesting to note the effect that a new apparatus has in a foreign country. An English newspaper publication recently published the following in regard to an apparatus recently installed by the Lancashire & Yorkshire Railway Co. in Bradford, England, for the recovery of oil from waste. The innovation evidently attracted much attention and the local U. S. consul considered it of sufficient interest to contribute the item to the *Daily Consular Reports* where it was reprinted. Centrifugal apparatus for recovering the oil in chips, waste and rags is an old story here:

> In a large works, or where there is much machinery running, the quantity of oil that is absorbed by waste rags and wipers in the course of a year is considerable, and with oil at war prices, any method of recovering even a portion of it is worth considering. An apparatus has been in use by the Lancashire & Yorkshire Railway Co. among others, by which it is claimed that 90 per cent of the oil and grease held in the pores and on the surfaces of waste rags and wipers used in keeping machinery clean is recovered. The arrangement is a skillful adaptation of the steam turbine and centrifugal or hydro-extractor as it is sometimes called. The centrifugal consists of an outer containing fixed cylinder and an inner perforated cylinder which is made to revolve at a high speed. The material to be dried is placed in the perforated cylinder and when the latter is revolved, the material to be dried is carried by centrifugal force against the perforated wall of the cylinder, any fluid which it contains being carried through the perforation into the outer containing cylinder, from which it is drawn off. The apparatus is driven by small steam turbines and the exhaust admitted into the revolving cylinder helps to loosen the grease and facilitate its extraction.

* * *

CHANGE IN TYPE OF HEADS OF SET-SCREWS

The National-Acme Mfg. Co., Cleveland, Ohio, has adopted a standard for the height of heads of set-screws in accordance with the following rule: *The height of head of standard set-screws shall be equal to three-quarters the diameter of the body.* These dimensions will be used for all sizes of set-screws carried as standard stock by the company. But until 1917 either the old or the revised style of heads may be considered regular and will be furnished at standard prices. The company will urge the adoption and use of the U. S. standard thread on cap- and set-screws and the virtual elimination of the V-thread.

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TOOL ENGINEERING

The leading article of this number deals with tool engineering in motor car engine manufacture and is similar in treatment to that on the military rifle in which the methods and organization required for manufacturing rifles were described. In this article, the organization of the tool engineering department of a motor car factory is described and the analysis of manufacture of the engine is carried out for all its principal parts. The types of machines and tools are specified and the operations are named in order of performance.

The chief value of articles of this sort is that they bring together the means and methods generally known and apply them to the solution of given problems, carrying the work through from its inception to conclusion. No one needs to be told that articles of this nature are rarely found in technical publications or that the publication of an assembly like this is of great practical value. There is no doubt about it. It is one thing to know a number of related and unrelated facts and quite another to be able to bring these related and unrelated matters together to form a useful whole. The weakness of trade literature generally is that it consists mostly of scraps of information useful in proportion to the experience of the readers. Inexperienced readers get many ideas and much help from reading technical publications, but we propose to give them more than valuable ideas and useful facts. We shall in these articles give the plans which may be taken complete—modified or extended, as the case may require—and applied to manufacturing practice. Undoubtedly there is need for this industrial preparedness work which will serve to educate mechanics in planning efficient and systematic manufacturing operations. To ambitious men these articles mean opportunity to learn and to get on in the world.

* * *

BALL BEARING SPINDLES IN MACHINE TOOLS

Ball and roller bearings are being used in machinery of all kinds with gratifying results, but comparatively few anti-friction bearings have been used for the spindles of machine tools. The conservatism of machine tool builders and users, and the high cost of the bearings required to insure dependable and satisfactory results have been the reasons. The machine tool designers claim that ball bearings for lathe spindles are practically unnecessary, as the friction loss is so small as to make little difference in the power consumption, and that the high cost of anti-friction bearings and the danger of breakdowns are good reasons for not using them.

It is true that the apparent friction loss in a lathe spindle bearing is small and that the resulting power economy would not pay returns on the difference in the cost of plain bearings and anti-friction bearings. But this feature of machine design has another aspect to which designers, builders and users of machine tools may profitably give earnest attention. It has been shown by tests that a ball bearing spindle may be made freer from chatter than a plain spindle working under the same conditions of load, and as everyone knows, chatter is the foe of efficient metal cutting. The moment the work or tool begins to chatter, rapid deterioration of the cutting edges begins. The tool will soon break down and require removal and grinding. The loss of time resulting from regrinding the tool and resetting is an appreciable factor in the day's production.

Excessive chatter is usually noticeable when work is being done while held on a faceplate or in a chuck and without tailstock or steadyrest support. Then the whole pressure of cutting is transmitted to the spindle and spindle bearings. When the work has considerable overhang the pressure of the cut on the front spindle bearing is considerably increased by the leverage of overhang. Under such conditions the average mechanic would not think of trying to take a heavy cut with an ordinary engine lathe unless he provided either steadyrest or tailstock support. But if he were able to dispense with these supports, much time would often be saved in chucking the work and removing it when finished.

Tests on lathes built with extra heavy spindles and ball bearings adequate for the work designed have shown that the spindle possesses remarkable anti-chatter characteristics. The reason is not obscure. They are due to general rigidity and the elimination of excessive friction in the bearings. When a lathe of ordinary design with plain bearings is subjected to the test of turning a piece held in the chuck with the end projecting several inches, the pressure of the cut is often sufficient to break down and squeeze out the oil film between the spindle and the bearings. The result is metal-to-metal contact and excessive frictional resistance. Chatter begins in the headstock bearing itself, and being transmitted to the work is intensified, with the result that the tool point speedily breaks down. In view of this unsuspected cause of machine tool inefficiency our conservative machine tool builders and users may find that they were mistaken in their estimate of the lack of possibilities of ball bearings in machine tools. Efficiency of cutting may be so greatly increased that no user who counts cost and return on investment can afford to purchase a lathe or other machine tool without anti-friction bearings on the work-spindles.

* * *

THE USE OF SOFT METALS IN MACHINERY CONSTRUCTION

Every mechanic is familiar with the use of babbitt for the bearings of machines, but the use of soft or low melting point alloys for uniting machine members is not so well known, although it has been practiced for many years. Not long ago it was common practice in the manufacture of low-priced drilling machines to fit certain brackets and pads to the sides of the column by pouring babbitt between the brackets and the column while the brackets were held in a suitable fixture. In this manner, the brackets were located in the proper position and provided with a secure bearing on the column without the chipping, filing and squaring up that were inseparable from the ordinary hand process. In the manufacture of certain shop furniture, the cast-iron shelves are made with cored holes in which the pipe legs are placed, while the shelves and legs are held in a fixture. Then a low-melting alloy is poured around the pipes in the cored holes, and when it solidifies the shelves and legs are firmly united, making a cheap and durable construction.

The use of type metal to secure bearing bushings in cored machine castings, while the bushings are lined by mandrels supported in a jig, is apparently a new development in machinery construction and one that has wide application. It permits castings to be converted into machinery with slight expense for machine work. The cast-iron bushings are bored, of course, and they may be babbitted if babbitted bearings are required. The type metal used to secure them in place is of a lower melting temperature than babbitt. Brass or bronze bushings may be secured in the same manner.

It would be interesting to trace out the history of the use of soft metals for securing machinery parts in proper relation. In the early days of steam engineering, salammoniac mixtures were used largely in engine building for the purpose of making joints and uniting parts that are now generally assembled by pressure or shrinking in. Many other examples could be cited in which cements and alloys have been used for securing machine members. These have been looked on as cheap makeshifts unworthy of advanced practice, but the low-melting hard alloy may become a revolutionary factor in the design and construction of many kinds of machinery.

* * *

AN APPEAL FOR BETTER PATENTS*

BY OTTO ABDT

It is a well-known fact that comparatively few of the six hundred patents issued in this country each week ever net their owners a cent. The reason for this, however, is not so well known. The majority of those who flock to the Patent Office to protect their ideas do not know, and they are paying a dear price for worthless literature because of this ignorance. They want patents, and patents they get; but patents are like eggs, for there is just as much difference between patents and *good* patents as there is between eggs and *good* eggs, and it takes a practiced eye to separate the good from the bad. Very often the inexperienced inventor has that unlimited confidence and faith in his brain child which is not unlike that which parents have in their human offspring. A well meant or kindly word of criticism of his invention is quite likely to roil his dignity if not to arouse his enmity. He is notedly suspicious and bears an unenviable reputation for lack of business acumen. None know his faults better than the patent attorney and, notwithstanding a general impression to the contrary, the attorney has very little opportunity to take advantage of him. There are exceptions, of course, but most of them, if traced to the core, will disclose the fact that complaints of this nature lie mainly with the inventor himself.

The attorney's fees are small, and fixed, and unless agreed upon to the contrary he cannot afford to make exhaustive searches and expend any great amount of thought in planning claims for the average case. He leaves the judgment of procedure to his client for the reason that the client is expected to be capable of judging what features of his invention he wants to protect; but the inexperienced client is inclined to shift the burden of his troubles to the attorney's shoulders. The attorney obtains a patent for him and there his interest in the case ceases. If it infringes another patent it is not his fault, and if it is unsalable it is not his fault. He has acted according to the instructions of his client who only too often blames the attorney because he has a worthless patent on his hands. Very often he openly accuses his attorney of sharp practice in this case, and the risk of becoming a victim of the predatory is not a thing of the past by any means. Just so long as he chooses to remain a simple, unsophisticated soul, he is likely to suffer from this source; but if he understands the rules of the Patent Office and a few ins and outs of the game he is fairly well protected.

The average inventor is a delicate customer to handle and guide properly. He scents conspiracy at every hand and is given to brooding over things he imagines will happen to him and deprive him of his rights. His path is usually strewn with disappointments. If he is given a patent, no matter how his claims may read, and oblivious to his liability to infringement should he attempt to manufacture the particular thing he believes he has patented, he is a happy man. His friends then flock to him and pay homage to the superior knowledge his invention proclaims him to possess; but when he tries to dispose of his patent at the fabulous sum he thinks it is worth, he soon becomes disappointed and his friends lose confidence in him. His next move is to curse those to whom he thinks his invention should prove valuable, because they tell him, politely enough, but nevertheless convincingly, that they do not care for it. He suspects these very rejections are handed him for the purpose of misleading him and that these people are going to steal his invention outright. He does not know that if it were as valuable in their eyes as he assumes it to be it would have been snapped up before the forms were cold from its issue. Neither does he know the risk large companies would assume if they attempted to appropriate the object of his patent.

It is as true of patents as other assets—they will not sell unless they are worth something to someone other than the owner. And what one is worth is not necessarily determined by the ingenuity displayed in a mechanism nor by its simplicity, but in its practical demonstration, the scope of the claims, the cost of manufacture, and the market. These are essential to a salable patent. Most of the really valuable inventions comprise a new way of producing an established product—something that has demonstrated its demand by continued usage. The invention of a new thing requires educating the public to its usage; a market must be created for the product, and it must be in keeping with present-day perfection and scope of manufacture. In this case the prospect is based on theory from the beginning, and unless backed by considerable capital and engineered by experts is likely to end disastrously. It matters little how good a prospect may look from an inventor's viewpoint; the people are the judges of what they want and are not easy to convince. Substitutes for the real thing are regarded with suspicion by a desirable class of trade, and no one knows this better than the manufacturer who strictly fulfills the public's demand for quality. He is not bothered by the new things that appear on the market and goes steadily on, leaving the mushroom novelties that spring up in his path to make the best of their short lives, for they serve only to strengthen him.

A patent on an improvement does not, as a rule, net the inventor anything because the thing improved has a prior right within the limits of its claims and covers the improvement during the life of the original patent, thus preventing the manufacture and use of the improvement. Claims for an improvement are limited, of course, only by the state of the art in which the improvement is made, and in an established art of long standing it is a mighty good improvement that cannot be avoided by the manufacturer. Whether or not he can do this is about the first thing he considers when a patent or an idea is sent to him for consideration, for it is seldom that anyone not connected with a concern in a capacity that will allow him thorough familiarity with what is required in the way of improvements can develop anything which cannot be avoided to advantage. It is not human nature, having the means at command, for one to buy a thing that he can make himself better than others can. So the manufacturer does not steal the invention or the idea, as the inventor is inclined to think; but if he finds that it embraces certain desirable features, he investigates the claims, becomes familiar with their limits and, in nine cases out of ten, finds they are easily avoided in attaining a better result. He is entitled to do this, and it is considered poor business to waste an opportunity of this kind. In a way it seems rather small to take advantage of an inventor like this, but if the inventor does not first become familiar with the rules of protection the government offers him, and does not spend an adequate amount of thought regarding the essentials which will make his invention a good one, he cannot expect anything else.

A glance through almost any issue of the *Patent Office Gazette* will convince those of a practical mind that many subjects of patents are things that are really old and have not seemed of enough importance to certain users to pay for

* For additional information on patents and allied subjects, see "Who Owns the Patent Rights?", February, 1916; "What is a Patent Worth?", January, 1916; "The Patent-Bee," October, 1914, and articles there referred to.

getting a patent on them. If traced to the real inventor they would prove useless to the patentee. But to illustrate the impractical tendency of many others, one has but to turn to the patents issued on non-refillable bottles. Mechanical ingenuity is here displayed on an elaborate scale. The inventors seem to have lost sight of the fact that a bottle, whether refillable or not, would have to be made for a cent or two in order to meet present-day commercial needs. They have, in most cases, failed to take into consideration how bottles are blown, and that a hand manipulation to set diaphragms inside a blown bottle would be prohibitive in most cases; yet devices of this nature which would cost at least a dollar to produce are very common in these patents. Even if a perfect non-refillable bottle could be produced at an expenditure of one cent more than the standard open-necked kind, it is open to question whether the big users of bottles would consider its adoption. The present method of molding a trademark in bottles effectually prevents competitors exchanging them, and makes a bottle commercially useless to all but the original filler. To say that the glass companies would unanimously adopt the non-refillable type is mere conjecture. One company might get control of it; but if it did not continue with the open-necked bottle also, the competition would be likely to be embarrassing. It is doubtful if the largest users of bottles, such as breweries and dairies, would ever consent to the increased expense entailed by using the non-refillable bottle even at the price they pay for the open-necked kind. At present, they use bottles over and over again, but the life of the non-refillable type ends with the first filling, and it is obvious that the consumer would be the victim. Undoubtedly there would be a great demand for a practical invention of this kind; but "practical" in this case is rife with the elusive qualities of perpetual motion.

Take novelties: If it be an extravagant toy, the sale is limited to people of means and wealth, and just how far this extravagance is carried determines the bounds of this limit, and the dies and tools required for its manufacture might be too costly to consider the thing commercially profitable. Then, too, the ever-changing attitude of the public toward novelties might cause the thing to be placed upon the market prematurely or it might be too late. Novelties which are simple, attractive, and are adapted to economical production are sometimes very profitable; but the skill required in marketing things of this kind is a big factor in their success or failure. The inexperienced person will do well to make arrangements with novelty manufacturers on a royalty basis, rather than to attempt to manufacture himself.

Machinery is still another consideration of the inventor. Here he indulges his ingenuity to the greatest extent, and many seemingly good inventions are idling out their lives because they are covered by a basic idea and themselves take the form of improvements. Better that some of the inventors of these machines had restrained their impatience and nursed their ideas to perfection that they might have the chance they deserve at the expiration of the basic patent. Of course the ridiculous is found here, too. As an example of what one can still expect, the writer has had two requests lately to pass judgment on perpetual motion machines. The simple souls who are laboring to solve this impossible thing are still unaware that the government refuses to allow patents on machines of this class. It is an impossibility to convince those unfamiliar with the laws of mechanics that the thing is impossible, and useless to try.

A patent is, in sense, a license to make, use, and sell the thing for which the patent was issued, within the boundaries of the United States and territories thereof; but in reality is likely to prove a ticket to the courts if the patentee is not thoroughly acquainted with what really belongs to him, and he usually is not. Patents overlap in a maze of interferences, and only an expensive procedure, prohibitive to the average inventor, can safely determine whether a patent is operatively independent of others or not. This fact is a boon to the predatory capitalist who feels at liberty to appropriate anything to his own needs that looks good to him without consulting the party of the second part. The original invention in any new art requires no more ingenuity than is necessary to improve the art in some instances, and if this improvement can be made in a different way, it should be admitted. If the latter invention should be limited to details, why not all? The basic inventions are usually obsolete after a few years, yet they are allowed to demand a royalty from devices vastly superior and of which the pioneer could have had no conception. The government grants the right to make and use the thing patented, but at the same time it hands out the patent with the admonition, "I give you permission to make and use the thing, but you go over and fight Jimmy Green, and if you whip him, provided no one else shows up who wants to fight you, you will be safe."

We want better patents! Inventors want protection that protects! But in view of present conditions it is impossible for the inventor to do more than improve his knowledge of the game and not leave everything to his attorney whose interest lies within his profession and is limited to the size of his fees. It is often good policy to pay the price of his expert opinion, and, too, a second thought will sometimes save the price of a worthless patent. One would hardly attempt to enter the banking business without any knowledge of banking, nor enter the insurance business without knowing anything about it; but it seems that many try improvements in more complicated lines than either of these with a mistaken idea of what is really required. Opportunity is rife for the inventor, but he will have far greater success if he familiarizes himself with all the details he can master of this complex and fascinating profession.

* * *

DETERIORATION OF FIREBRICK LINING*

A mixture of fireclay and water, having no binding strength, is not a proper material to use in laying firebrick. Firebrick of a quality best suited to meet the furnace conditions is generally selected without careful consideration of the permanent adhesive quality of the material to be used in the joint. The maintenance of furnace firing is a large item in the cost of production; not only must the cost of repairs or renewals be considered, but also the decreased production owing to the time lost. Usually the falling of an arch, the bulging of a wall or excessive cutting away of a portion of the interior of a furnace can be attributed to a defect in the joint. The fireclay disintegrates or falls out, allowing the heat to work in between and attack the lining, thus shortening its life. Very often an arch is lost owing to the clay becoming loosened around one of the roof bricks and falling, resulting in weakening the whole structure. Fireclay does not support the bricks. It works loose from expansion and contraction and permits small particles to work in between, gradually widening the spaces until the openings are large enough to admit the circulation of the gases, and resulting in ruining the structure.

* * *

DRILLING MACHINE SPEEDOMETERS

The highest efficiency of twist drills is obtained when the revolution speed and feed are correctly proportioned for the work in hand, whether it be steel, cast iron, brass or other metals. One who has given much attention to the design of drilling machines and who has long supervised their use in manufacturing, advocates the use of speedometers attached to each machine, by which operators may instantly determine the actual revolution speed. Then, if a table is provided which gives the proper revolution speed and feed for each size of drill, there can be no good reason for not running the machines at their highest efficiency. It is difficult, however, to obtain a reliable speedometer having the range required. A low-priced instrument usually is not reliable, and if not reliable, it is worse than none at all. Reliable instruments, having the range required, are high-priced and might in some cases cost as much as the drilling machine itself. Evidently, there is an opportunity for someone to work out a low-priced, reliable and wide-range speedometer for drilling machines and other machine tools.

* Extract from paper "Tests of High-temperature Furnace Cement," by W. S. Quigley, read before the Philadelphia Foundrymen's Association, May 3, 1916.

MACHINING A THIN BRASS WASHER

In response to a query regarding machining the brass cast washer shown in Fig. 1 at *A*, the following method is suggested. The washer is to be turned to 2¼ inches outside diameter and 2 1/64 inches inside diameter and faced to a thickness of ⅛ inch. The machine best suited to this class of work is a hand screw machine having a cone-driven spindle capable of high speed, or a brassworker's lathe having a turret head. Referring to Fig. 1, the work *A*, being in the rough state, can be held to advantage in a step chuck *B* which is operated by the collet closing mechanism at the rear of the spindle. The movement of the collet closing lever causes the portion *C* of the chuck to move forward in such a way that the tapered chuck piece *B* is closed down on the work, thus holding it firmly. This chuck piece is split on the periphery in three places, 120 degrees apart, so that the contraction caused by closer *C* moving forward will result in a uniform radial movement of the split portion of chuck piece *B*. It will be seen that the chuck piece is bored out to receive the work *A* in such a way as to allow a portion of the work to stand out beyond the face of the chuck so that it can be faced without interference.

The tool used for boring and facing is held in the turret by the stem *L* which enters one of the turret holes. The body *D* of the tool is cut away at *E* and grooved to allow the tools *F* and *G* to be positioned as shown. The tools are clamped in place by the strap *H* which is operated by a collar-head screw *K*. It will be seen that tool *F* can easily be adjusted for diameter and that facing tool *G* can be so placed that it will start to cut at the proper time after the boring tool has finished the hole. The upkeep on a tool of this kind is good and replacement can quickly be made in case of breakage.

If a number of washers of this kind are to be machined rapidly but without close limits of accuracy, one tool such as that shown should be sufficient to do the work. If, on the other hand, a very nice job is needed, both roughing and finishing tools can be used. In the first setting of the work the hole is bored and one side faced, leaving the outside to be turned and the other side faced in the second setting. Fig. 2 illustrates the method of holding the piece for the second setting, using a special nose-piece *C* mounted on the spindle. To this nose-piece is attached stop collar *D* having a projection which comes against the work *A* and gives the longitudinal location. This projection is slightly smaller than the outside diameter of the work so as to permit the turning tools to pass by in machining. The part *B* is split in three places in a similar manner to the chuck portion shown in Fig. 1. A tapered hole at *F* permits expansion of part *B* by a movement of the plunger which is operated by the collet closing mechanism. In order to prevent any tendency to move forward, collet *B* is held in sleeve *E* by a nut and washer in the spindle (not shown in the illustration). When the taper plug *F* is pushed forward, member *B* expands and grips the inside of the work.

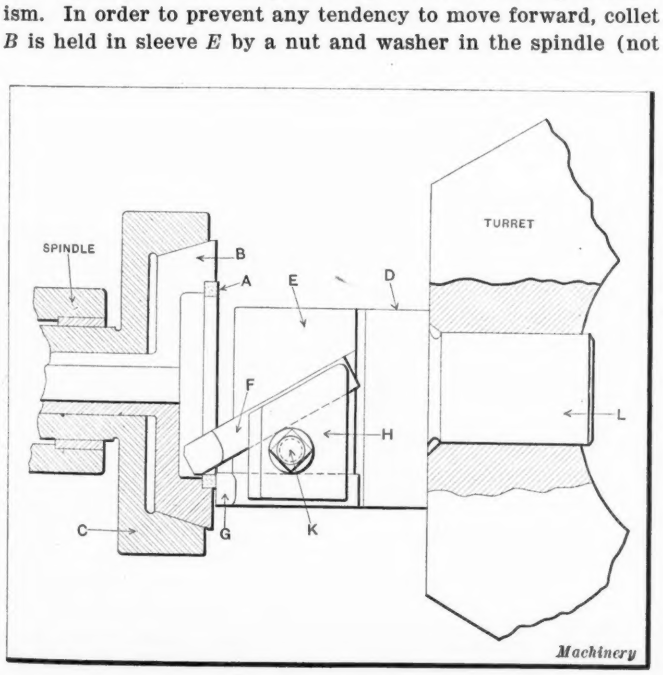

Fig. 1. Tooling used for First Setting on Thin Brass Washer

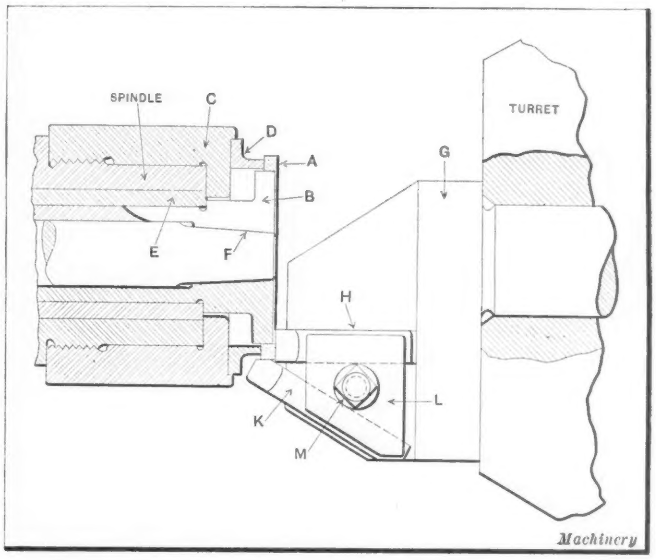

Fig. 2. Tooling used for Second Setting on Thin Brass Washer

The tool recommended for this setting of the work is of a box type having an outside turning tool *K* and a facing tool *H*, both of which are secured in place by clamp *L* and collar-head screw *M*. In general construction this tool is similar to that used in the first setting of the work, and the holder *G* is held in the turret in the same way. In this case, as in the preceding, the inside finish desired would determine whether one or more tools were necessary for the operation. In machining yellow brass, it would be safe to assume a cutting speed of 200 feet per minute without lubricant. The tool should be ground according to the quality of the metal and should be kept keen in order to produce a nice finish. Speaking generally, the softer the metal which is to be cut, the greater "hook" will be required on the cutting lip of the tool.

By using the type of tool illustrated herewith work of the kind mentioned can be produced at the rate of about 120 pieces per hour, allowing for both roughing and finishing cuts in each setting of the work. A. A. D.

* * *

With a little horse sense, a broken tap can be made as good as new by means of a grinding wheel. A mechanic was handed a broken tap and asked to put it in good working condition. He squared up the end of the tap on the face of an ordinary tool grinding alundum wheel. Then he ground the relief or chamfer. * * * A little skill is required to cut a radial relief and keep the cutting edges of the lands even. Radial relief and even height of the lands are the two main things to look out for when putting an old tap in good condition. The tap should be held lightly against the face with the wheel turning toward the cutting edge of the tool. This gives an edge that is free from burrs and is slightly better than one ground with the wheel running in the opposite direction. The tap must be held firmly enough so that it will not accidentally turn, carrying the cutting edge against the wheel and thus grinding it off. The operator should keep turning it slightly so that a little more will be ground off the back of the teeth and a radial relief obtained. There is always more or less danger of drawing the temper, and particular attention should be given to bearing lightly when grinding and to using a free and cool cutting wheel. The second important thing to look out for is that all lands are left even—the same radial height. If they are not even, the tap will not start true. A pretty good method of testing out a tap to find if the lands are even is to turn it about two-thirds through a nut and look at it from the opposite end. It can readily be seen whether or not all the lands are at work. * * * The length of the relief is another important consideration and one on which opinions differ. Ordinary plug taps are made with chamfer tapered four or five teeth back. Opinions have been expressed that for general use a tap ground back six threads works better and lasts longer than one ground back only four.—*Grits and Grinds.*

MANUFACTURE OF HACKSAW BLADES

STEEL USED, MACHINING OPERATIONS, HARDENING, STRAIGHTENING, AND TEMPERING

BY FRANK M. SHAW*

THERE are good and bad features in nearly all manufactured products, and this is particularly true of hacksaw blades. The buyers of hacksaws are governed by different standards in deciding upon the type of blades which they will use. Those who follow the most far-sighted policy select that type of blade which will do the greatest amount of work for each dollar expended, but there are other customers who are governed entirely by considerations of price, and still others who try to select blades with reference to both of these features. This makes it necessary for the hacksaw manufacturer doing business on a large scale to make blades of various qualities which are produced from different grades of steel; and there are three grades of steel commonly used in the manufacture of hacksaw blades. These are conveniently designated as Nos. 1, 2, and 3; No. 1, which is a tungsten steel, is the best grade; No. 2 is a high grade of carbon steel, and although not so tough as No. 1 steel, it still makes a good saw blade; No. 3 steel contains just enough carbon to enable it to be hardened. It is natural that steels of various compositions are used by different hacksaw manufacturers, but in practically every case the No. 1 steel contains rather more than 1 per cent of tungsten. It is also important for the gage of the steel to be absolutely uniform. Saws made of such material and given the proper heat-treatment are exceptionally tough and long-lived. The No. 2 steel is also required to be of uniform gage, and some steels of this grade contain small percentages of chromium and vanadium. Saws of this material properly made and heat-treated will give good results. In addition to the usual metal containing a small percentage of carbon, the No. 3 grade steel may be of the composition called for by grades Nos. 1 and 2, but such steel has been sold under a No. 3 classification because its gage is not uniform. At best, the saws made from No. 3 steel will be short-lived because the small percentage of carbon makes it difficult to properly harden the blades, while a lack of uniformity of the gage will result in rapid destruction of the saw, even though the composition of the steel is such that it can be heat-treated to the best advantage.

Despite the shortcomings of blades made of No. 3 steel, many users of hacksaws claim that carelessness on the part of their employes makes it desirable to use such blades, because in any case they will be broken as a result of carelessness before they have been in use for a sufficient length of time to be worn out. The writer believes this argument to be fallacious, as a fair test will clearly prove that saws made of No. 1 steel will do an amount of work under average factory conditions that will much more than offset the difference in price. In this connection it should be mentioned that hacksaw blades that are used in power machines are seldom made of any other grade but No. 1 steel.

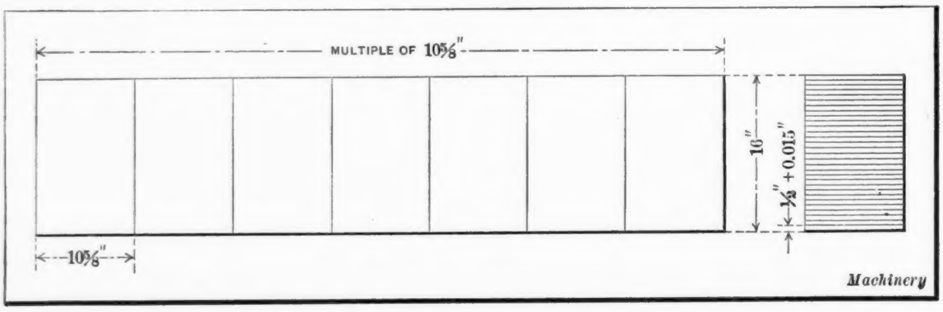

Fig. 1. Diagram showing how Sheet Steel is cut up into Saw Blade Blanks

When received at the factory, the steel is packed in boxes containing about 700 pounds of metal which is in the form of plates 16 or 18 inches wide, and of any length which is an even multiple of the length of the saws which are to be made. For instance, if the steel is to be cut up into blanks for 10-inch blades, the plates will be 16 or 18 inches wide by some multiple of 10⅝ inches long. The extra ⅝ inch provides for waste which is unavoidable in trimming up the ends of the blanks. It has been mentioned that it is highly important for the steel plates to be carefully rolled in order for the thickness to be quite uniform; otherwise, blades made from this steel will have a tendency to bind in the work, and this will result in their rapid destruction. For the best hacksaw blades the maximum variation in thickness must not exceed ± 0.001 inch, but in some cases the variation actually ranges from 0.0035 to 0.005 inch, and steel of this kind could only be used for No. 3 blades even though its chemical composition would enable it to be properly classified as No. 1 or No. 2 steel.

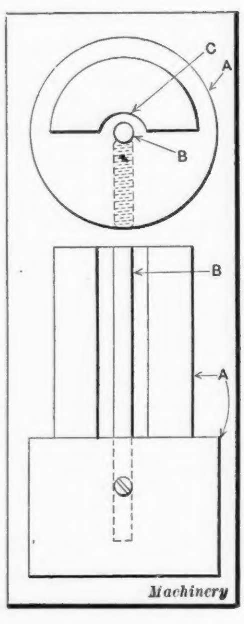

Fig. 2. Piercing and Trimming Die used for finishing Ends of Saw Blade Blanks

In fabricating the steel plates into hacksaw blades, the first operation consists of cutting the metal into strips of the desired length, *viz.*, 10 5/8 inches, 12 5/8 inches, etc. These strips are subsequently cut up into saw-blade blanks which run lengthwise of the strip. This is important because in the process of rolling the steel plates, the fiber of the metal is drawn out in a longitudinal direction and the best results will not be obtained unless the fibers run right through the saw blade. The blanks are cut about 0.015 inch over size to allow surplus metal for milling them to the correct width.

A power shear is used for cutting up the steel plates and this machine is equipped with a stop-bar supported by two side bars, the arrangement being such that the position of the stop-bar can be set to suit the size of saw blades which are being made. The idea will be best understood by reference to Fig. 1, which shows in diagrammatical form the way in which the plate is first cut up into sections and the manner in which these sections are cut up into saw-blade blanks. Referring to this illustration in connection with the statement made concerning the stop-bar on the shear, it will be evident that the stop must be set to provide for cutting blanks of different lengths, and in the case of the blanks illustrated the setting will be for cutting off lengths of 10 5/8 inches. The side bars which support the stop-bar are graduated

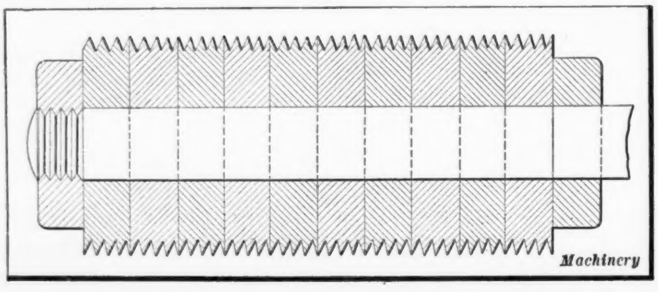

Fig. 3. Cross-section of Milling Cutter used for cutting Teeth of Saw Blades

* Address: 94 Dunmoreland Ave., Springfield, Mass.

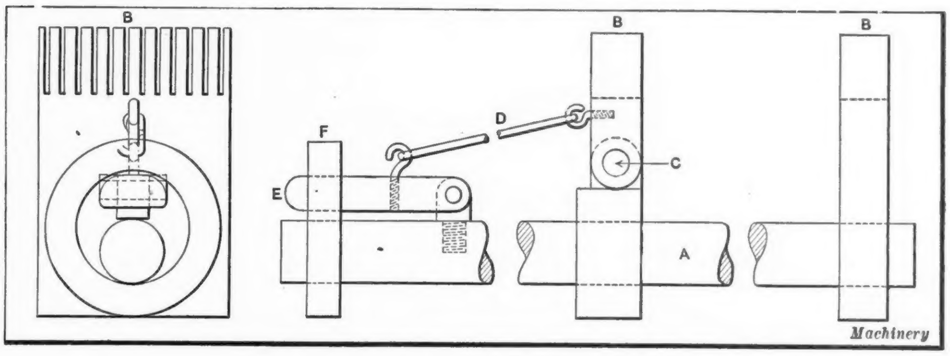

Fig. 4. Frame used for dipping Saw Blades into Lead Bath

for different standard lengths of blanks which have to be cut. The holes are punched in the ends of the saw-blade blanks at the same time that the ends of the blanks are rounded to the required shape. For this purpose the press is equipped with a set of combination piercing and trimming dies of the form shown in Fig. 2, and different dies have to be provided for the different sizes of blades. The piercing punches on these dies are rather easily broken, but they may be renewed at slight expense. Fig. 8 shows a close view of the die on an E. W. Bliss punch press arranged for stamping and piercing the ends of two hacksaw blades at a time; but the machine only works on one end of the blade at each stroke and the work is fed into the die by hand. Three methods are used for punching the holes and trimming the ends of the blanks so that they will be of the correct shape and length. The slowest method consists of punching and trimming one end at a time, and when this plan is followed the rate of production will be just about one-half that which is attained by the use of more efficient equipment which provides for operating on both ends of the blades at once. The presses used for working in either of these ways may be operated by the usual form of foot-treadle, and the stock fed into the die by hand. Naturally such equipment compares very unfavorably with presses provided with automatic feed and dies which operate on both ends of the blanks at the same time. Using the latter form of machines, an operator of average efficiency can turn out from seventy-five to one hundred saws per minute.

Practically all hacksaw blades have milled teeth, and the machines on which the milling operation is performed are usually provided with duplex fixtures so that the cutters can be working on blanks held in one side of the fixture while the saw blades are being removed and fresh blanks substituted at the other side. Each section of the fixture has a capacity for holding about three gross of blades 0.025 inch in thickness, and the time required to mill the teeth in this number of blades is about fifteen minutes. Fig. 7 shows a Hendey milling machine set up for milling the teeth in hacksaw blades. This illustration clearly shows the arrangement of the multiple milling cutter, which is composed of a number of sections assembled on an arbor. The milling cutters are made with staggered teeth and are furnished in sections 1 inch wide; they are made of high-speed steel and often cost in excess of $500 per set. As hacksaw blades are made in a number of different pitches, *i. e.*, 6, 8, 10, 12, 14, 16, 18, 24 and 32 teeth per inch, it will be seen that a complete stock of cutters for use in hacksaw manufacture represents quite a large investment. A set of cutters will mill from 200 to 225 gross of saws before having to be resharpened.

In sharpening the cutters great care must be taken to do the work under exactly the correct conditions, as many cutters have been ruined through the carelessness or inexperience of the operator causing him to take too heavy a cut or to do the work with a wheel that is too hard for the purpose. A 6-inch "saucer shaped" wheel is used which is 30 grain, J grade. The cutters are placed on an arbor, as shown in Fig. 3, and care must be taken to place the cutters on this arbor in the proper order, because the teeth are staggered and they must be correctly located in relation to each other so that the grinding will be done properly. Great care must also be taken to see that the radius of the cutter is constant from end to end. For this purpose a simple form of surface gage is used which is 1 inch wide, *i. e.*, the same width as each section of the milling cutter. This gage is placed on the table of the grinding machine and a tissue paper feeler is used to test the accuracy of the cutter from end to end. If the least discrepancy is discovered it must be corrected by "touching up" the part of the cutter which is found to be in error, or by tapping it lightly with a lead hammer if it is found that the section of the cutter under test is held too high on the arbor. When the sharpening has been completed, the cutters are ready to be sent back to the machine for further service.

The angle of the teeth of hacksaw blades varies considerably, each manufacturer having a standard which he believes to be the best. For example, saw blades are made with tooth angles of 50 degrees and 55 degrees. It will, of course, be evident that the milling cutters are made with teeth of the same angle, and in performing the milling operation care must be taken to set the cutter at exactly the required height; should the milling cutter be lowered too far the saws will be milled in such a way that their width will be below the standard size. The milling cutters are lubricated with mineral lard oil.

After milling, the saws are removed from the fixture and placed in trays on which they are transferred to the setting department. In setting the saw teeth, use is made of a machine shown in Fig. 9, which is provided with two wheels that have teeth meshing with each other. The pitch of these teeth is the same as the pitch of the saw teeth to be set,

Our No. B 1672 Date 12-7-15 Your No. 9275

Name American Machine Co.

Address Chicago, Ill.

QUANTITY	LENGTH	WIDTH	GAGE	PITCH	TO CUT	STEEL	LAST ORDER
100 gross	10	1/2	23 .025	16	General work	#1 Colonial	#1 Colonial
75 gross	12	9/16	22 .028	18	Tool steel	#1 Jessop	#1 Jessop

Machinery

Fig. 5. Form of Cards used to record Orders received for Saws

SHOP RECORD

Our No. B 2247 Date 1-12-16 Your No. C 18245

Name Williams Co.

Address Buffalo, N.Y.

Shipped 1-21-16 Via Fg't, B. & A.

LENGTH	WIDTH	GAGE	PITCH	HARDENING	TEMPERING	STEEL	MARK	QUANTITY
14	3/4	18	10	1425	370	Crucible	Regular	40 gross.

Machinery

Fig. 6. Form of Cards used for recording Orders that are being filled

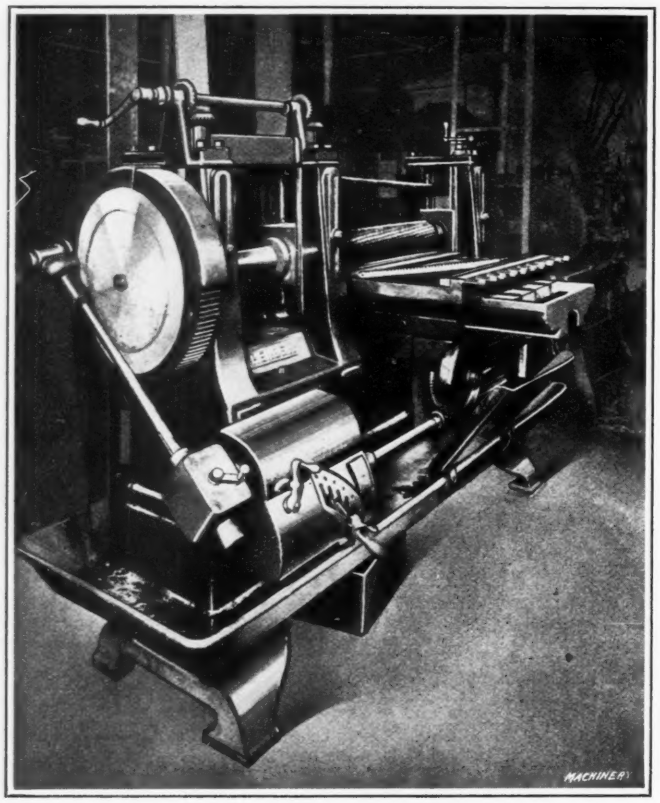

Fig. 7. Hendey Milling Machine equipped for milling Teeth in Hacksaw Blades

and the position of the upper wheel is adjustable to provide for obtaining the desired amount of offset for the teeth of the saw. The illustration makes the use of the machine so clear that further description is unnecessary. The setting of the saws is a very important matter, but although accuracy in the performance of this operation is absolutely necessary, there are a number of different styles of setting which give satisfactory results. The regular alternate form of setting generally used consists of offsetting alternate teeth an equal amount in opposite directions. Another method of setting is to have every third tooth left on center, with alternate teeth offset in opposite directions. Still another method is the alternate full and half setting, in which two teeth are given a slight offset while the next two teeth are given a full offset. Saw blades with thirty-two teeth per inch are commonly provided with a double alternate set, *i. e.*, two teeth are offset alternately in each direction. Examples of each form of setting are shown in Fig. 10. The amount of setting or clearance given to the teeth also varies in the products of different manufacturers of hacksaw blades. In connection with the work of setting it will be of interest to know that about ninety gross of 12-inch saws can be set in a ten-hour working day, and it is possible to operate the setters for about a day before they become sufficiently dull to require grinding.

After the saw teeth have been set, the blades are placed in trays which consist of boards 5 feet long by 4 inches wide provided with notches to support the blades on edge. They are placed in these trays with all the teeth facing the same direction to facilitate inspection. Every saw is inspected to determine its straightness, correct set, and accuracy of the punched end holes. A few saws from each batch are also tested in a machine to ascertain their cutting qualities both as regards speed and endurance; and flexible-back saw blades are also tested for hardness with a file.

Blades which have satisfactorily passed inspection are ready to be stamped with the manufacturer's name, and at the same time that the stamping operation is performed the teeth at each end of the saw are rolled flat for a distance of 1 inch. The marking dies are carried on rolls between which the saw blades pass, and similar plain rolls are used for straightening the teeth at each end of the saw blade. The marking is only done at one end. About thirty gross of saws can be stamped per hour.

After stamping, the saws are ready to be hardened and this can be accomplished by several methods. The use of lead baths is quite common and these may be used in different ways. One method is to place the saws in frames and then dip them in molten lead at a temperature of about 1400 degrees F.; after the blades have been left in the bath for a sufficient length of time to reach the required temperature, they are quenched in oil.

Fig. 4 shows the frame in which the saw blades are supported for hardening by this method. It will be seen that the frame consists of a bar *A* which is about 6 feet in length. The saw blades are held in notches cut in plates *B;* one of these plates may be adjusted back and forth on bar *A* to provide for holding saw blades of any required length. It will be seen that one of the plates *B* is pivoted at *C* so that it may be allowed to swing over to release the work from the notches. In loading the frame with saw blades, this hinged plate is allowed to swing toward the fixed plate at the end of the bar, after which the saw blades are dropped into the notches, and pins are slipped through the holes at each end of the blades. The frame is then tightened by pulling link *D* forward so that bar *E* may slip through the notch in plate *F*, in which position it is secured by a latch. After the frame has been loaded in this way it is immersed in a lead bath which is usually about 36 by 12 inches in size and 8 inches deep. The work is left in the bath a sufficient length of time to come to a temperature of 1400 degrees F., after which the frame and work are immersed in oil. After being given sufficient time to cool, the frame is removed from the oil and put aside to drain, after which the saw blades are removed. Held in this way, the saw blades are kept straight so that trouble from distortion is avoided. This is known as the "wet lead" hardening process.

In contradistinction, there is the so-called "dry lead" hardening process, which is carried on by placing a number of saws in tubes made of a special alloy. These tubes are mounted on a sort of ferris wheel which revolves over a pot of lead in

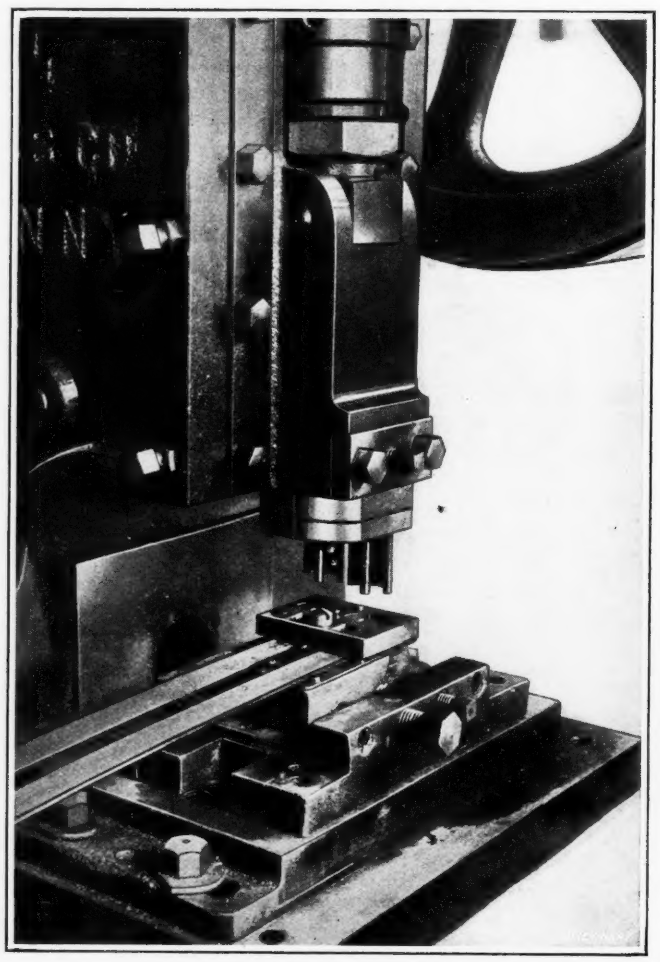

Fig. 8. Close View of Die used on E. W. Bliss Press to punch One End of Two Blades at Each Stroke

ANALYSIS OF DIFFERENT ALLOYS CLASSIFIED AS NO. 1 SAW BLADE STEEL

Tungsten, Per Cent	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Chromium, Per Cent	Vanadium, Per Cent	Sulphur and Phosphorus, Per Cent
0.55	1.10	...	0.20	0.80	...	0.020
2.00	1.25	0.50	...	0.25	0.25	0.025
1.15	1.15	0.20	...	0.25	...	0.020
1.75	1.00	0.40	0.20	0.20	...	0.025

Machinery

which the lower tubes are submerged, the temperature of the lead and speed of rotation of the wheel being such that the saws will have time to attain the required temperature. Although the heat is derived from the molten lead it will be evident that the saw blades do not come into actual contact with it. A better finish is said to be obtained in this way.

Still another method of hardening calls for the use of a furnace about two feet long which is provided with gas burners at intervals of one inch; the saws are passed over these burners, and as they emerge from the other end the steel is quenched by a stream of oil which flows onto it. In using this method the blades are linked together so that they may be drawn through the furnace. A variable-speed mechanism is provided for drawing the blades along, so that the speed may be regulated to meet the requirements of hardening saw blades of different thicknesses; and an idea of the rate of production will be gathered from the fact that about eighteen 8-inch saws, 0.025 inch in thickness, can be hardened per minute.

After large blades for power machines have been hardened it is sometimes necessary to straighten them, and this is usually done by hand just after the saws have been removed from the quenching bath and before they have cooled. Barring exceptional cases, the saws can be straightened satisfactorily in this way. Several methods are used for hardening flexible or so-called "soft-back" saw blades. One of these consists of heating the saw for a distance of about 1/32 inch

Fig. 9. Close View of Setting Rolls on Machine used for setting Teeth of Hacksaw Blades

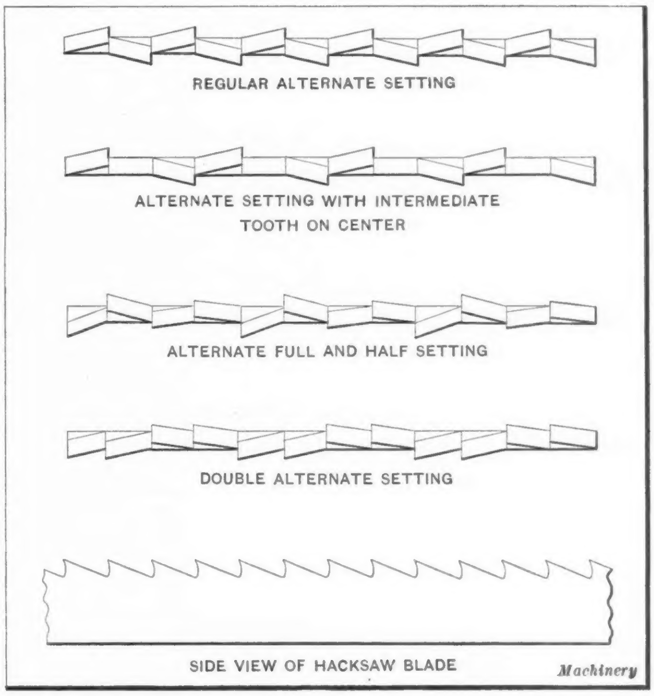

Fig. 10. Diagram showing Standard Methods of setting Hacksaw Blades

below the teeth and then quenching it with a cold blast of air. Heavy iron plates protect the work at both sides to prevent the backs of the blades from being heated to a hardening temperature. The saws are run through the machine with the teeth up, and the temperature is carefully regulated to the required degree.

Regardless of the method in which the hardening operation is performed, all types of saw blades are tested for hardness before being shipped. For this purpose the test is made on a saw from each batch, which is tested in order to make sure that the desired cutting qualities and toughness have been obtained.

After hardening, the saws are packed in pans and tempered in oil, the temperature to which the oil is raised depending upon the work which is being handled. For instance, saws made of No. 1 steel, 21 gage, having fourteen teeth per inch, are generally tempered at 390 degrees F., while the same saws with thirty-two teeth per inch have their temper drawn at a temperature of 415 degrees F. To remove the oil after tempering, the saws are tumbled in sawdust, after which the ends are "blued," which means that the metal is softened at this point by heating the steel with gas flames. About thirty gross of 21 gage saws may be blued per hour; from the bluing machine the saws are taken to the packing room where they are first inspected for hardness by noting the color, and then counted into dozen lots. After this they are wrapped or wired together and packed in boxes containing one-half gross, which are labeled to show the length, width, thickness, pitch and grade of the saws. Records of all saws made in the factory are kept on the forms shown in Figs. 5 and 6.

* * *

ELECTRICITY ON THE FARM

The telephone is doing much to relieve the isolation of farm life, and the automobile is also contributing to the same end. Where good roads exist the automobile puts a farm ten miles out of town practically as near as was one two or three miles out before its advent. Another factor that is making farm life more agreeable is the isolated electric power plant. Complete gasoline power units are now sold for $250, having a capacity of 750 watts, or enough to supply thirty 25-watt lamps. They generate a low-voltage current—32 volts—and are always ready, as a storage battery forms part of the system. Hence, it is not always necessary to run the engine when light or power is needed. With this little power plant, every well-to-do farmer can provide his own electric light at low cost, as well as power for operating household machinery, grinders, etc.

THE METRIC AGITATION

CHANGES INVOLVED IN SUBSTITUTING METRIC SYSTEM FOR ENGLISH METHOD OF MEASUREMENT

BY LUTHER D. BURLINGAME*

Fig. 1. Reproduction of an Old Envelope used to advertise the Metric System

ATTENTION is now being directed to a document, "The Metric System in Export Trade," prepared by S. W. Stratton, director of the Bureau of Standards, which is a report to the International High Commission, meeting in South America, relative to the use of the metric system in export trade. Having been published as a Senate document, it is being given wide circulation at the expense of the government.

This report was prepared with the apparent purpose of influencing legislation so as to bring about, by compulsory means, the adoption of the metric system in this country. In the opinion of experienced men, and especially those acquainted with the details of the requirements of the industries affected, such a change would, by breaking away from fundamental standards and having two standards in use in our shops instead of one, result in great confusion and enormous expense; and all this with no commensurate gain; indeed, with the saddling on our industries of a system in many ways less satisfactory than the one we should lose.

Dr. Stratton's report, while exaggerating the advantages of the metric system, especially as to stimulating the development of our foreign trade, minimizes its objections and the difficulties of making the change. It is the purpose of this article to discuss the points raised in Dr. Stratton's report and to show why we should not sacrifice the established standards of this country; to cite some of the reasons why the plan to make the sole use of the metric system compulsory in this country in the near future, as urged by him and embodied in the measure now before Congress, would be detrimental; and to show why the measure should be opposed by those having at heart the best interests of this country and its industries.

It is not the intention in this article to go into a general discussion of the whole metric question; and while much might be said regarding the objections and serious difficulties of changing other standards involved besides those for linear measures, this discussion will be confined to the latter, as it is in the changing of linear measurements that our industries will be most vitally and seriously affected.

In considering the question of changes in linear measurements bare mention will be made of many matters of great importance, such as land and nautical measurements, board measurements, measurements used in connection with railroads and in the textile industries, and an infinite number of other details, such as sizes of window glass, camera plates, automobile tires, etc.; but attention will be directed to the effect of the change on the mechanical trades principally, such a change being of the most vital interest and concern to the manufacturers and mechanics represented by readers of MACHINERY. The general question of a change from our present system of linear measurements to the metric system will be considered, as well as the use of this system in foreign trade, as Dr. Stratton has repeatedly stated that any moves for partial use, such as in the departments of the government, or for foreign trade, are but stepping-stones to complete adoption, and would be abortive unless followed by complete adoption.

In the report to the International High Commission five objections to the adoption of the metric system are mentioned and discussed by Dr. Stratton with the purpose of showing that they are trivial and should not stand in the way of making a change, of which (as claimed by him) the resulting advantages would more than offset the objections. The objections which he discusses are:

1. The difficulty of having two systems in use instead of one.
2. The cost of changing.
3. The loss of workmen's present familiarity with values represented in customary terms.
4. The loss of basic standards, or if old standards are maintained, the expression of their values in metric equivalents.
5. The loss of the present uniformity in the English-speaking world.

The various points in connection with the foregoing will be discussed in the order named.

Two Standards Instead of One

Dr. Stratton urges in answer to the first objection that we already have the two systems, and that therefore it is too late to consider this objection. He cites a number of American manufacturers who are claimed by him to be using the metric system, thus proving that the two systems are being used together voluntarily and without difficulty. Among these manufacturers, he names the Brown & Sharpe Mfg. Co., the Pratt & Whitney Co., etc., and in so doing gives to the commission, to Congress, and to the public an entirely wrong impression. The Brown & Sharpe Mfg. Co. does not use two systems in its manufacturing in any sense whatever, but instead uses only the system based on the inch. I understand the same is true of the Pratt & Whitney Co. Furthermore, it would be looked upon by the officials of these and other leading manufacturing concerns as a great calamity if the metric system should be forced upon their shops and their workmen, and yet they are listed in the report as examples showing how easily the metric system can be adopted. The inclusion of these names in the list given in the report is no doubt based on the fact that these companies make measuring tools having metric dimensions for the market; this, however, furnishes no ground whatever for any such misleading statement as that made in the report. Metric tools, such as micrometer calipers, are made with the general dimensions based on the inch, and when metric lead-screws are made for machines to go to countries which have adopted the metric system, diameters and lengths are made to customary English measurements. The cutting of the metric thread is simply a matter of gearing up the thread cutting machine by the use of translating gears to give the required lead, and no workman in the shop needs to know anything whatever about the metric system to do the work.

The fact that the needs of foreign trade can be met in this way practically without using the metric system in our American shops, has been used as an argument by pro-metricists that, because work can be readily done in such a way, the metric system could easily be adopted by us. Such a view, however, simply shows ignorance of the fundamental difficulties involved in making a change to the use of the metric system. Some years ago, Dr. Coleman Sellers, in a paper before the American Society of Mechanical Engineers, explained some of the difficulties of using the metric system in an American shop. This paper was prepared as a warning to American manufacturers against metric legislation, which was then pending, and Dr. Sellers based his conclusions on twenty years' experience with the metric system at the works of

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William Sellers & Co., Inc., Philadelphia, Pa., where the system was introduced with the expectation that advantages would be found in its use, and an earnest effort was made to find such advantages. In this paper Dr. Sellers says:

> I propose to show why, after nearly twenty years' use of the metric system of measurement, I record my opposition to any enforcing legislation in this direction, because the metric system is not well adapted to the practice of the machine shop.

This company's use of the metric system was made in a department separate from other lines of manufacture, and Dr. Sellers explains why its use, when found to be disadvantageous, was not discontinued. He says: "Precisely the same reasons why we cannot change our general system into the metric hold against our giving up the metric system in the departments where it is in use"; and realizing the serious disadvantages of this condition, he urges American manufacturers to hold to their present system, and to "encourage the uniformity so desirable, rather than to attempt to make all things new, but in no respect practically better, at so frightful a cost."

If we should make a change affecting the departments of the government, such as the War and Navy departments, and if our factories were producing material for these departments, and war should come upon us during the transition from one system of measurement to the other, it can readily be seen what confusion and loss would follow and what a serious handicap the use of two systems would be in effectively prosecuting a war, the successful issues of which are now so well understood to be dependent on the mechanical industries. Even though the metric system was legalized in this country fifty years ago, and efforts have been persistently made since that time to bring it into use in the daily lives of the people, it has not come into use in any such sense as to warrant the statement made by Dr. Stratton to the effect that we now have two systems in use, or the further statement made by him that the metric system is used one hundred times as much today as it was a few years ago. Judging by the sale of metric tools in this country, as shown by the orders of large tool manufacturers, there has not been any relative gain in the use of such tools. In fact, the contrary seems to be true, in spite of the periodic efforts made by the pro-metricists to force the system to the front. In many American shops where they are doing work in the metric system, such as munition work for countries which have adopted this system, the dimensions are translated into English equivalents; in other cases gages are used, by means of which any knowledge of metric measurements on the part of the workman is unnecessary.

The claim that the metric system has been increasing in use is an old slogan of those who are urging its adoption, as will be seen from Fig. 1, which shows an envelope used in the early 80's to advertise the Metric Bureau of Boston. On this envelope is the statement, "The adoption of the metric system is now making rapid progress in this country." The use of the inch as a standard of measurement is as yet so nearly universal in the shops of manufactories throughout this country that it is believed to be entirely incorrect to say that "we now have two systems in use."

Cost of Making the Change

Dr. Stratton makes a comparison between the cost of measuring tools in the English and metric systems, and because he finds that the metric measuring tools are no more expensive than the measuring tools based on the English system, takes the position that the cost of making the change would be negligible. The real cost of making the change is thus ignored. Just the single item of changing the figures on drawings to give the metric equivalents, even if the dimensions were not changed to integral metric sizes, would be an immense task involving the probability of many serious errors. In one case which comes to mind, where the system of numbering parts in the factory was changed for only a part of its product, the cost of changing the drawings and records was found to run into many thousands of dollars. This change, however, was trivial in comparison with what would be involved in changing drawings alone to the equivalents in the metric system; and even after the drawings are changed, the expense has just begun. Fig. 2 shows how just one portion of a drawing typical of ordinary conditions would be changed if the metric equivalents were used, and all mechanics will admit that this half-way change would be entirely unsatisfactory, even aside from the first cost of making the change.

Many thousands of dollars worth of special tools are required in the ordinary process of manufacturing machinery.

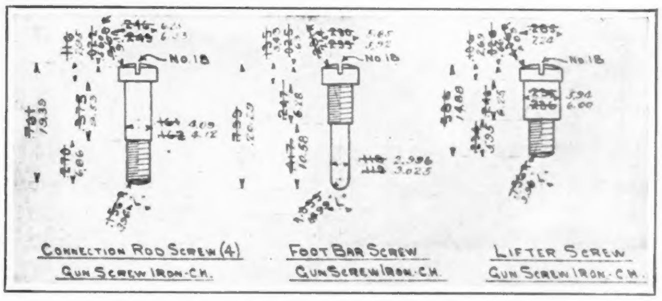

Fig. 2. Appearance of a Drawing changed over from English to Metric Measurements

Among these are special measuring gages which have the sizes stamped on them, as illustrated in Fig. 3, which shows a set of tools for the small needle-bar clamp guide *A* for a sewing machine. If the company making the machine of which this is a part should adopt the metric system, it would mean that all these dimensions would have to be expressed in metric units instead of thousandths of an inch, and it can be readily seen what it would mean to remark these tools. If the actual dimensions should be changed to integral metric units, as pointed out by an able defender of our system—Henry R. Towne—to be the only logical way to adopt the metric system, even this cost would be multiplied many times, and interchangeability for repairs, etc., would be sacrificed.

The further cost resulting from the necessity of providing new basic standards, the handicapping of the skill of workmen, etc., will be mentioned under a later heading. Any attempt to revise the literature, especially the technical literature of the English-speaking people, while an utter impossibility, would, even if partly done, involve heavy expense.

The individual cost to the workman would also make a considerable item, as it would be necessary for him to invest in a new supply of measuring tools to replace such as are now in his kit which depend upon linear graduations. These cases cited are but suggestions of the items of cost involved, which, as pointed out by Dr. Sellers, already quoted, would be "millions on millions." To show that this is not mere generalizing, I quote further from Dr. Sellers' report:

> In regard to what is involved in each shop size, in a money point of view, I will give but a single example. The inquiry to our own tool-room keepers for a list of the separate devices used in producing one size, *viz.*, 1¼ inch, brings to me the names of 129 articles or sets of articles, such as drills, reamers, gages, boring-bars and cutters, taps of all kinds for all sorts of uses, hardened mandrels, etc. These pieces, costing many hundred dollars, represent one size only. They tally with and belong to the dimension marked 1¼ inch in many thousand places on drawings which have been accumulating for years, to patterns loading down our pattern lofts, to gear wheels interchangeable over a continent, and to the output of our factory for years.

The Workman's Handicap

The workman's handicap in the loss of dexterity when using an unfamiliar system of measurement is an important point to be considered in the adoption of a new system. Workmen who have had years of experience dating back to their apprentice days have become familiar with the inch and its subdivisions. They not only know the fractional sizes of the inch as they do their A. B. C.'s, but have worked to thousandths of an inch and other fine measurements until a knowledge of these measurements has become ingrained in their experience. Prof. John E. Sweet strongly emphasized the loss which an abandonment of our present system would bring in this respect to our workmen, and he further said:

> The men who deal in ideas wish to dictate to the men who deal in things; the mathematician wishes to fix things

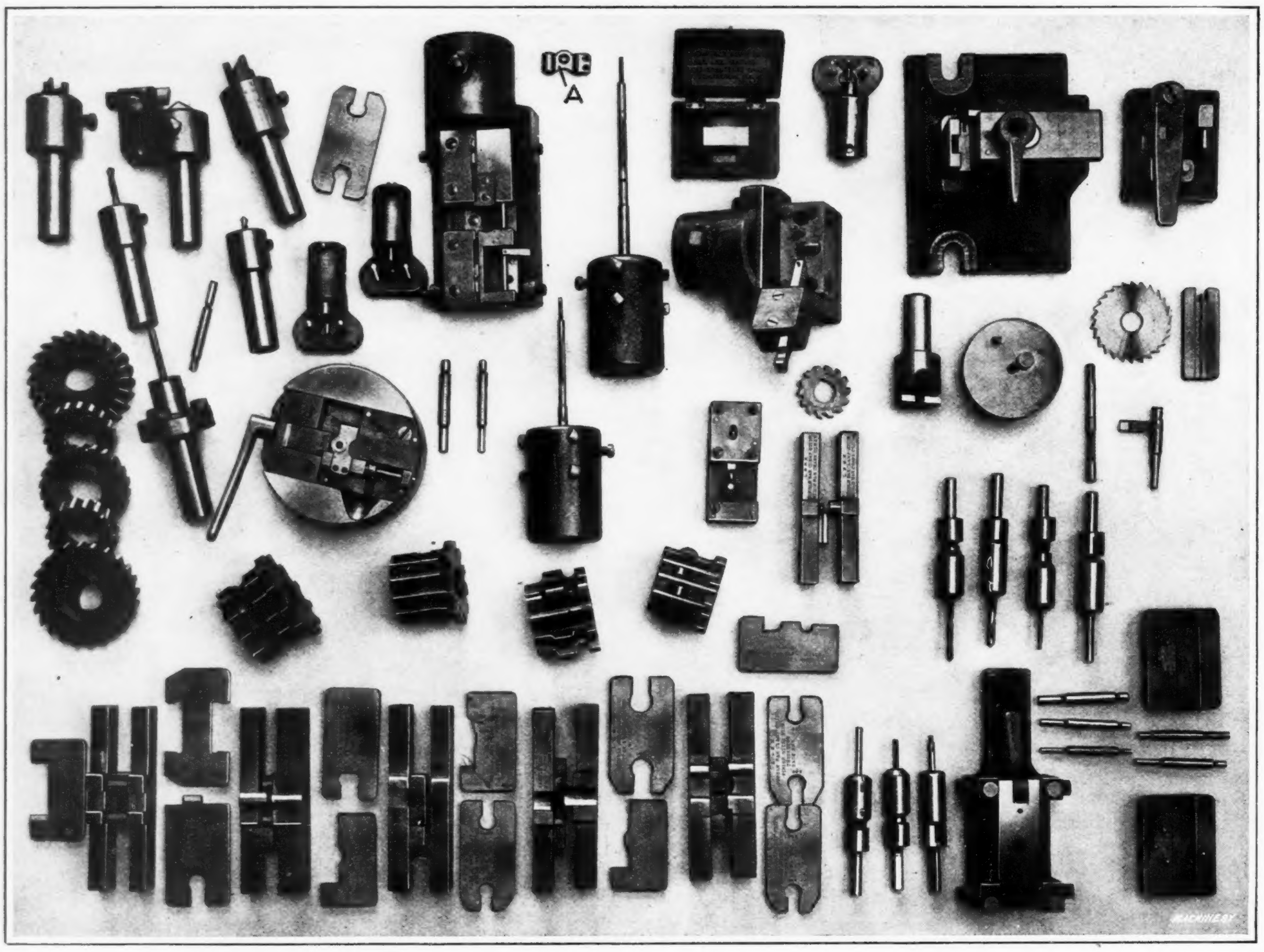

Fig. 3. Tools and Gages used in the Production of the Needle-bar Clamp Guide on a Sewing Machine

for his convenience at the expense of the convenience of the workmen, while there are one hundred workmen to every mathematician. The mathematician gains nothing in money, while the workmen will be put to millions in expense, and will not only receive no benefits, but so long as our present system exists and so long as things now made to endure are required, the double set of tools must remain; and it will be necessary for everyone reading an old book to translate the figures in order to comprehend or make use of the results.

He points out also that for a time, in many cases, the figuring will be multiplied tenfold, on account of the two systems in use side by side.

Loss of Basic Standards

The use of basic standards has laid the foundation for interchangeable manufacture. A pro-metric advocate, Hon. James H. Southard, ex-chairman of the house committee on coinage, weights and measures, admitted this in his report to Congress, although advocating the metric system. He says:

> In no other country has the construction of machinery reached a degree of perfection superior to that of our own, a result principally due to the system of interchangeable parts. The latter may be said to be a product of American ingenuity, and to be the greatest single advance in modern machinery. It has for its essential features a uniform standard of length and accurate length-measuring instruments. This work has been done upon the basis of the "inch" system.

The inch is today the standard of measurement used for the great majority of mechanical work of the world, not only in America, the British Empire and Russia, but also to a considerable extent in most metric countries; and we are asked to give it up as something which can be easily laid aside and in its place to substitute another unit. In discussing this question with mechanical men, it does not seem that it should be necessary to go into detail to show how serious a situation such a change as this might bring about. One or two illustrations, will, however, be given to suggest what points would be involved.

Let us take as an example a milling machine spindle having a standard arbor on which is mounted a gear-cutter for cutting gears of 6 pitch. The upper sectional view *A* in Fig. 4 illustrates how this is made at the present time. If the metric system is adopted, either one of two methods of procedure can be followed: first, to retain all the present interchangeable standards and express them in metric dimensions as shown at *B*; or second, to change these standards to integral metric sizes, in which case they will not interchange with machines already in use. It can be seen at a glance that either method would be very objectionable, if not entirely impractical.

As now made and illustrated in Fig. 4, there are, besides innumerable dimensions, at least nine standards involved. There is a No. 11 taper shank which is ½ inch taper per foot, 1¼ inch diameter at the small end, fitting in the milling machine spindle. This has a collar with a flattened section fitting in a 1½-inch slot in the spindle. The arbor itself is of standard 1 inch diameter. It has a sleeve running in an outer bearing 2 1/16 inches in diameter. The nut on the end of the arbor is tapped 1 inch in diameter, ten threads to the inch to fit the arbor, and is flattened to 1 5/16 inch to fit a standard wrench. There is a standard keyway in the arbor, and standard cutters with standard keyways fit upon this arbor, the illustration showing a 6-pitch gear-cutter, which, in itself, is part of a system of gearing based upon the inch. The thread on the end of the spindle is 4 inches diameter, three threads per inch, and receives standard tools, such as inserted-tooth cutters. A cap-nut also fitting on this thread is used to hold the arbor in place. All these standards are important, and it is absolutely necessary that they be maintained, in order to secure interchangeability.

Now the metric advocates tell us how easy it would be, if we do not desire to change these standards, to simply express them in metric terms, and to work to these metric equivalents instead of to our present sizes. Fig. 5 illustrates what kind of figures our American workmen would be expected to work to in order to comply with this condition. A

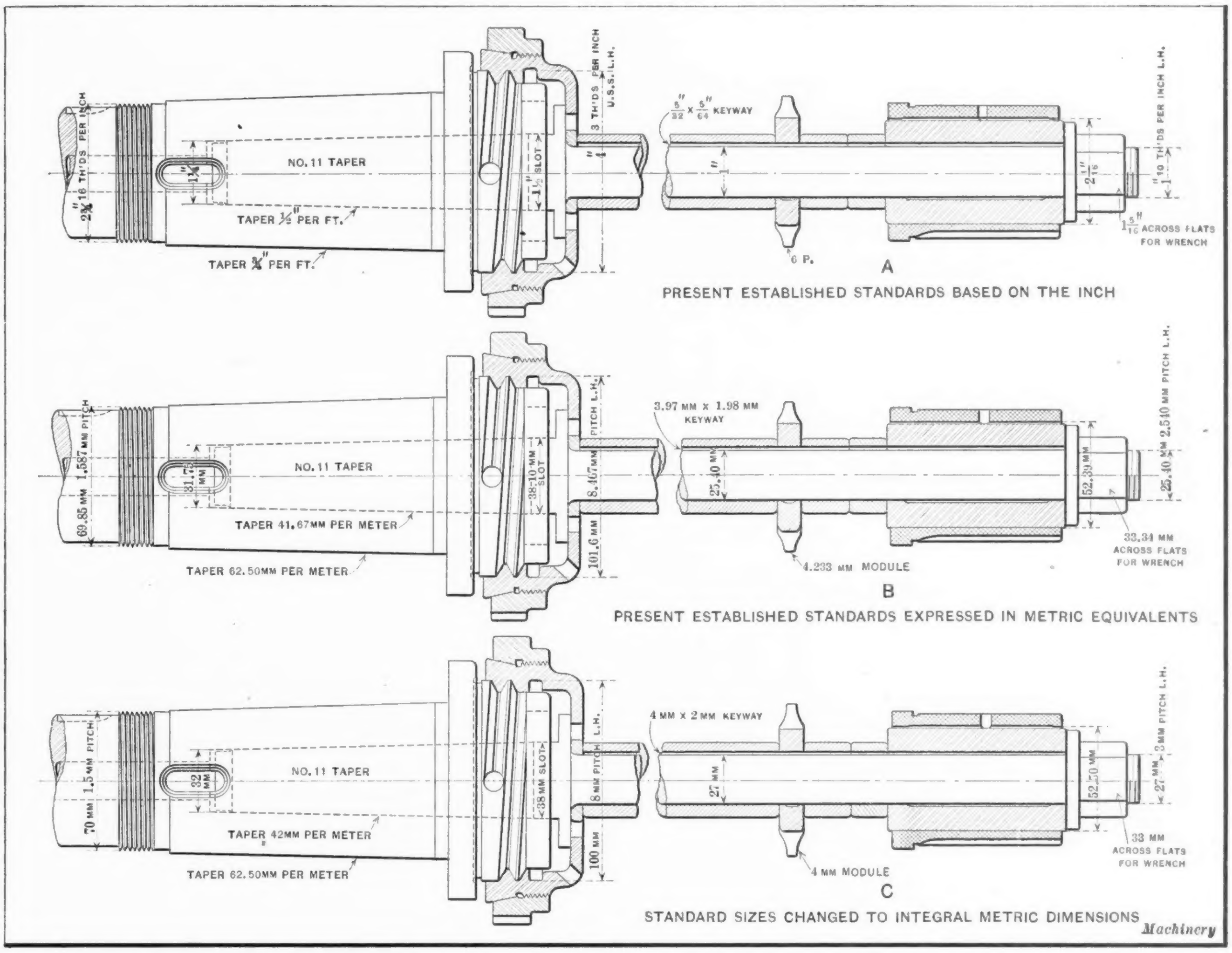

Fig. 4. Diagrams showing Difficulties experienced in changing over Milling Machine Spindle to Metric Measurements

glance at these figures will indicate how objectionable this would be. It is, however, the best attempt, after several trials, to do this "easy" job, which is for the purpose of making our work simple and saving time. The draftsman who made this drawing said, "If this is a sample of what we would have to do, I hope the change does not go through." Even if we should break away from all present standards and adopt integral metric sizes, as shown at *C* in the illustration, with the enormous additional first cost (though we put this great burden on our manufacturers), it would in itself be a serious handicap in competing for world markets, and we would have a much less satisfactory system after the change had been made, besides having sacrificed interchangeability. It is understood that several attempts have been made to adopt metric tapers for the holes in spindles of milling machines, drill presses, etc., but it was found that the standards for these based on the inch have become so fully established that even metric countries use them.

The gear-cutter on the arbor shows clearly that the system of gearing based on the inch is not commensurate with the system based on the millimeter, and this is further illustrated by Fig. 5, where in a pair of 8-pitch gears it is shown that with a given ratio of teeth, a change of system would require also a change in center distance if the gears were cut by the metric system. This would have to be changed quite materially if cutters of 3 millimeters or 3.5 millimeters module were used; and unless special cutters of 3.25 millimeters module were made, the change would be so great as to require redesigning and making new patterns for the housing in which the gearing is mounted, on account of the change in center distance, which even in the latter case would be changed more than 1/8 inch. This difficulty would also be present in the use of hobs for worm-wheels. The change in cutters and hobs would mean a large investment in even the average shop. The cutters sent out today can be used on any milling or gear-cutting machine because of having standard holes and keyways, whereas, by changing to metric sizes this advantage would be lost.

Millions of gears are being cut every year and are made interchangeable on the basis of the inch. A new gear can be cut to replace a worn or broken one or to add to a set already in use in a distant part of the country, even if the mating gear were made many years ago. The cutters for milling these gears are made in sets, and each shop adds to its stock as required. The introduction of the metric system would mean starting at the beginning, and accumulating a new set of cutters; and a century would not see the end of the confusion and expense which might be caused by such a change.

In order to maintain the interchangeability which we now have, it would be necessary, in addition to our present set of cutters, to have a set with the holes based on the inch to fit our present arbors, but with the pitch of the cutter made to the metric or module system; besides this, it would be necessary to have a set fully in the metric system, including the hole; and to be complete, another set would have metric holes in the cutters and be of diametral pitch based on the inch, so that our present style gears could be cut in the new machine. It might be said that this would make plenty of business for the makers of gear-cutters, but it would be a serious burden for the users, there being not only the cost of cutters, but also the danger of mistakes, delay and annoyance, and there would be no advantage in any respect whatever over our present system, either in making calculations or doing the work.

Few manufacturers make their product through all stages from the raw material and each is dependent on other manufacturers for supplying many of the partly finished details, such as chucks, transmission chain, finished shafting, grinding wheels, etc., made ready to go on machines built otherwise by them; and any change that did not take effect simultaneously in all these co-related lines would lead to misfits, delay and annoyance. Even if these were avoided, it would

require the doubling up of stock. This is illustrated by the use of grinding wheels. Standards for the holes in grinding wheels, where such a large stock must be carried to meet the needs, not only of different shapes, but also of varying grains and grades, would be sacrificed.

Other examples may be found in the diameters of shanks which fit the holes in screw machine turrets and in the width of standard T-slots in which many fixtures and tools fit interchangeably. Dr. Stratton says, "Where a size is not most efficient, it should be changed," here again showing lack of appreciation of the question involved, *i. e.*, the question of standards. Any one of the metric screw thread standards may be fully as efficient as the U. S. standard; and a metric width of T-slot may be as efficient as our present standard, but it is the breaking away from the standard which causes the trouble, and not the question of efficiency.

At the Brown & Sharpe works there are between five and six thousand different kinds of screws, studs, etc., carried in stock, representing many millions of parts constantly on hand. These are used interchangeably throughout the various lines of manufacture and for repairs to machines made in some cases generations ago. It is not evident how a change in these can be effected "simply" and "easily" and in "a short time, with small expense," as so glibly pointed out by pro-metric advocates, yet this is but a drop in the bucket compared with what we would have to go through if the change were to be made. Here again the suggestion to use metric equivalents instead of really changing the sizes would be absurd, especially in the light of the pro-metric argument that a change to that system would simplify our work.

Loss of Present Uniformity

The loss of uniformity between nations now using the inch as standard is the last one of the objections which Dr. Stratton so completely sweeps out of the way. This objection is the one dealing with the uniformity which we now have with all other English-speaking people, as well as with great nations that are not English speaking — uniformity which would be lost if we should abandon our present system. He points out that because there are now some differences in weights and measures among these nations, it is not important to try to keep such uniformity as there is. Any mechanic who stops to think will realize what practically complete uniformity there now is among the English-speaking nations in matters pertaining to the mechanical trade. The difference in screw threads is almost the one exception, and even here both systems are expressed in terms of the inch, and their relation is readily understood.

Dr. Stratton says that because "English exporters are using the metric system in export, it is an equally cogent reason why we should do the same." This is an implication that England is using the metric system in export trade in some way different from what we are, and that we should pattern after her. As I understand, England is using the metric system in foreign trade in just the same way that we are; *i. e.*, wherever the interests of her manufacturers dictate in producing or advertising goods which will be acceptable to her foreign customers, she uses the metric system without legislation or compulsion, and that is just what American manufacturers are now doing, have been doing in the past and desire to do in the future. Dr. Stratton further says, "If manufacturers and customers in metric countries can prepare products acceptable in the United States and England with their different standards of measures, it is incredible that America cannot reciprocate to meet the essential demands of metric countries by such reasonable use of metric terms in making or marking our products." Does Dr. Stratton mean by this to imply that these metric countries are using the English system of measurements when producing goods to send to America, and that imports into this country from metric using countries are being manufactured by the English system? Evidently not. And there is no more reason why we should, generally speaking, make our goods in the metric system to meet the needs of our foreign trade than that foreign manufacturers should make theirs in the English system to meet the needs of our trade.

One statement of Dr. Stratton's is very true, to the effect that "in using the metric system to promote the export trade with metric countries, common sense should take the practical turn of deciding how far its use is profitable." It is believed that our manufacturers and engineers are quite as competent to apply the test of common sense in this matter as theorists and legislators, and that they have been and will continue doing so as occasion demands, without the need of meddling legislation. I have before me a Brown & Sharpe catalogue of 1867 published in the French language, in which dimensions are listed in millimeters. Brown & Sharpe catalogues in French, German and other languages have been available when needed since that time.

Henry D. Sharpe, treasurer of the Brown & Sharpe Mfg. Co., said in a recent letter to *Current Affairs*, dealing with the relation of metric legislation to our foreign trade, "Instead of such a change being of benefit to our foreign trade, it would mean confusion to our home manufacture and use, placing a burden on us which would be a serious handicap in our competition for world markets"; and he further says: "The American manufacturer has never found any difficulty in obtaining this trade when he wishes to, as far as the matter of the metric system is concerned. He will make the pertinent dimensions of his goods to the metric system or any other system to suit the foreigner."

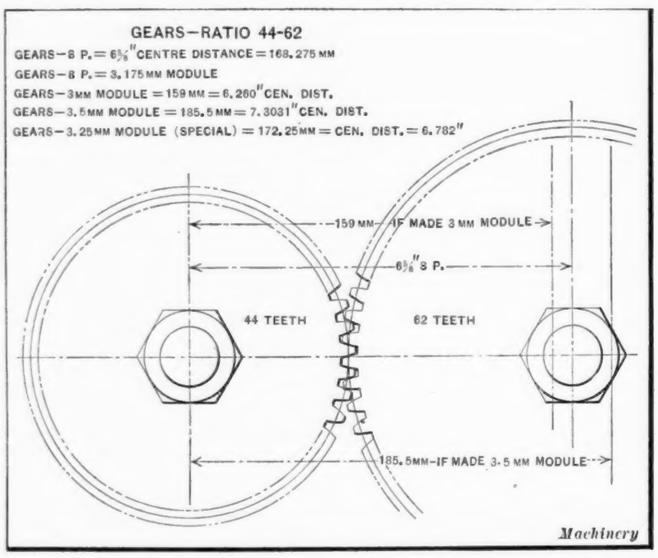

Fig. 5. Diagram showing Changes involved in Ordinary Spur Gears by the Use of Metric Measurements

Secretary McAdoo, in his communication commenting on Dr. Stratton's report, while endorsing the view that we should adapt ourselves to the needs of our customers, truly says, regarding the adoption of the metric system, "I am aware that it would be the work of generations, and would involve endless complications, if not waste, to change our present system for domestic use"; and the *Iron Trade Review* has said, editorially, "It has been demonstrated time and again that the expense to the manufacturers of this country, and particularly to those engaged in the machinery and metal trades, of changing from the English to the metric system would be enormous, not to say prohibitive, and without any compensating advantages."

After we had been all through this great upheaval, what would we have to show for it? I am among the many who believe that for the mechanical trades, and for use in the shops, we would not have in the metric system as convenient a system as we now have. The millimeter, the unit generally used in the mechanical trades where the metric system is in use, is so small that it must usually be expressed in many figures. The reason for its use to the exclusion of other units is to avoid confusion in the use of decimal points that would arise in using centimeters, decimeters, etc., and also to avoid the use of a multiplicity of units; so that the lesser of two evils is chosen. Even when compared with our fractional sizes which may sometimes use nearly as many figures, the metric sizes are not as easily carried in mind. Thus, 384 millimeters is not as easily carried in the mind as 9¾ inches, while 354

millimeters or even 350 millimeters would be much harder to remember than 9 inches.

There is no unit in the metric system as convenient as the inch, and there are no subdivisions of the metric unit as convenient for use as hundredths and thousandths of an inch, to say nothing of the fractional sizes, quarters, eighths, sixteenths, etc., so familiar to every mechanic. Another advantage of our present system is that it is adapted for either binary or decimal division. This is a convenience to the draftsman who, using binary divisions when scaling his drawing down, can make it one-half, one-quarter, or one-eighth size, according to the requirements—a convenience lacking in the metric system—and by using decimal divisions and multiples of the inch when it suits his needs, the draftsman has a full decimal system with all the advantages in calculations, etc., claimed for the metric system.

A number of years ago MACHINERY said editorially, in corroboration of this view: "So far as the use of the metric system in the machine shop is concerned, we believe it is not and never can be as convenient as the English system. The inch subdivided into one-half, one-quarter, one-eighth, etc., is an extremely convenient unit for proportioning machine parts, and when divided into a thousand parts, fulfills all requirements for the most delicate and accurate work."

The advocates of the compulsory adoption of the metric system in this country must be given credit for persistence and ingenuity in devising ways, often insidious in their character, to start an entering wedge for the adoption of this system. Ten years ago it was by proposing to make the system compulsory in all departments of the government. Now it is to secure action in South America which will pledge this nation to overthrow its present system. This is no idle fear. I quote from a report of the Committee on Coinage, Weights and Measures, to Congress, regarding the action taken a number of years ago by the first Pan-American congress recommending the adoption of the metric system.

The report says: "The other nations, parties to the conference, with scarcely an exception, have honorably proceeded to put in force in their respective limits the metric system then adopted. On what principles of international honor can the United States, the originator of the conference, stand alone in refusing or delaying to abide by its action?"

It is believed that the mechanical interests should take warning from the past methods of the metric propagandists and that they should see that no legislation is sprung upon them unawares. It is further believed that an earnest protest should be made from all these mechanical interests against any compulsory legislation affecting the standards of measurement in our shops.

* * *

TANDEM MILLING FIXTURE

With the idea of increasing production, the tandem milling fixture shown in Fig. 1 was designed by the W. H. Nichols Co., Waltham, Mass. The parts for which this fixture was designed

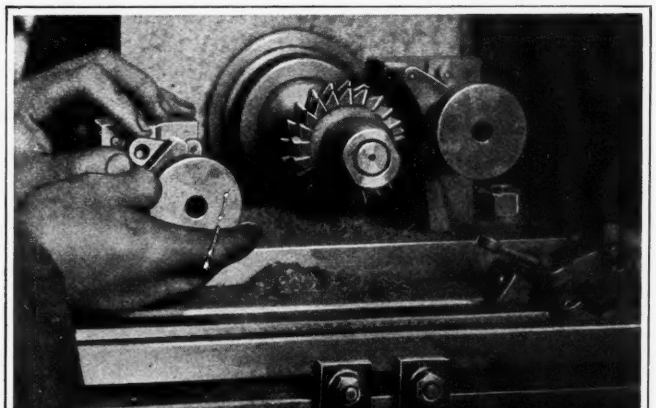

Fig. 1. Tandem Milling Fixture for facilitating Production

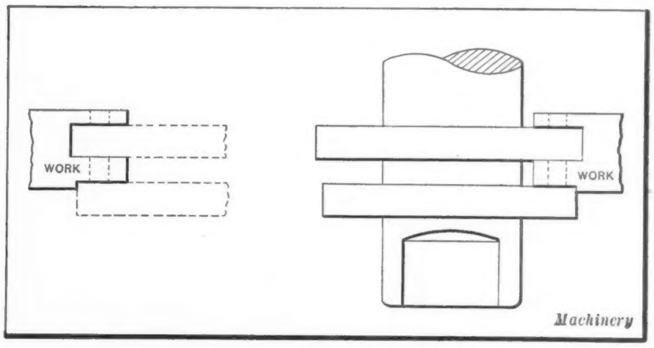

Fig. 2. Diagram showing Relation of Work and Cutters

are the small malleable iron, tabulating-machine cam levers shown to the right in Fig. 1. These cam levers are located from pins in holes that have previously been drilled and reamed in a drill jig. The width of the slot must be machined to close limits, as well as the width of the lug, which is straddle-milled, and it is important that the milled surfaces be exactly at right angles with the holes.

The operation of this fixture is as follows: While the cutter is milling the lever in the right-hand end of the fixture, the operator removes the lever which has previously been milled from the left-hand end of the fixture and replaces it by an unmilled lever, tightening up the hand knob as shown. By this time, the other milling operation has been completed and the advance of the table has been stopped by the feed trip. The operator then feeds the table by hand close up to the left-hand end of the fixture, throws in the power feed and loads the right end of the fixture. Thus the operation is practically continuous. A plan view of the arrangement of cutters and work is shown in Fig. 2.

It is customary to run the cutters at a speed of approximately 64 R. P. M., with an advance of the work of 0.017 inch per revolution of the cutter, which is approximately 3 inches in diameter. Under the conditions stated and by the use of this fixture, one operator has machined as many as eighty levers per hour and will average approximately 720 levers per ten-hour day. These production figures speak for themselves. It is safe to say that this fixture should nearly double the output obtained with the ordinary single fixture. V. B.

* * *

Although the diamond wheel is the most efficient means of truing grinding wheels, there is perhaps no more unknown quantity as regards durability and dependability in such general use among mechanics than the average diamond used for truing wheels. This is due largely to the fact that bortz are of natural formation. Moderate priced stones, especially the brown bortz, have much to recommend them over the more costly stones. The diamonds generally used for wheel truing are of five classifications: brown bortz, gray bortz, Jagersfontein, Ballas and black carbon. These five may be obtained in various sizes and qualities. Of the five classes, the grays and browns are the cheaper grades, while the Jagersfontein, Ballas and black carbon are more costly. Between the grays and browns there is not much difference. The gray stones are harder, and this might be a recommendation to some, but besides being harder, they are also much more brittle. They will stand far less shock than the brown bortz, and as there is not much difference in cost, the latter seem preferable. The brown bortz have certain properties that recommend them above the others for grinding wheel truing: (1) They are sufficiently hard to withstand reasonable wear. (2) They are obtainable in shapes that lend themselves to proper setting. (3) They are not as brittle as some bortz, especially gray bortz. (4) They are not as expensive as Jagersfontein, Ballas or black carbon. (5) If the stone proves to be soft, the loss is not as great as would be the case with a more expensive diamond. (6) The less experienced purchaser may detect flaws more readily in the brown bortz than in the other kinds. (7) Diamonds may be easily ruined by careless use, and this is true of the expensive as well as the cheaper grades.—*Grits and Grinds.*

TESTING LEE-ENFIELD BAYONETS

GENERAL REQUIREMENTS–GAGES USED–WHIP TEST–COMPRESSION TEST–BEND TEST–HARDENING

BY JOHN J. RALPH*

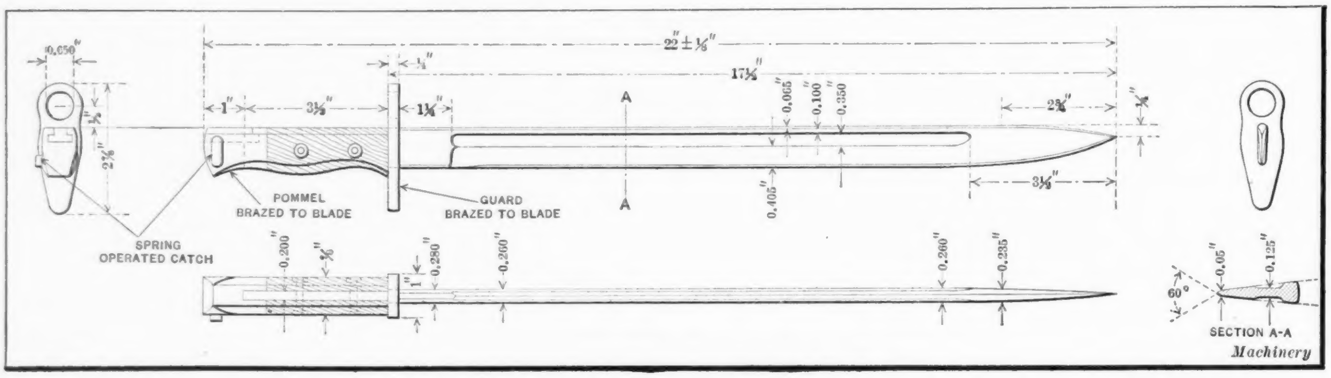

Fig. 1. Bayonet for Lee-Enfield Military Rifle

AMONG the earliest war orders were those for rifles and bayonets, yet these were not received in this country until five months after the war started. These first orders were accepted by the larger arms manufacturers and necessitated new factories and organizations. In the majority of cases, the companies to whom the contracts were let were more or less unfamiliar with the requirements of government manufacture, with the result that the work produced and offered for acceptance was far below the standard until severe lessons through rejection forced a change in methods, gages, and even materials in some cases. The general lack of specific knowledge of the class of work necessary on military rifles and bayonets is largely responsible for the tremendous losses which have been incurred by a number of companies. In some cases many orders have been executed at an actual loss where profits should have been great if manufactured under proper methods and supervision. The essential features to be observed in this class of manufacture are thorough mastery of the technical problems involved, careful planning and designing preliminary to actual work, and provision of the highest class of tool equipment and gages used in testing the work.

Bayonet Specifications

Fig. 1 shows an approximately correct drawing of the bayonet used on the Lee-Enfield military rifle, and a summary of the specifications is given herewith.

Sword bayonet must conform to pattern and standard gages, subject to limits given in drawing and conditions of specifications.

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Quality of material must be as specified, and where not specified, quality and workmanship to be the best possible.

Bayonets subject to inspection during and after manufacture. If one-quarter of the delivery is inferior to pattern or contract specifications, the whole consignment is liable to rejection.

Material, crucible steel, carbon 0.90 to 1.10 per cent; phosphorus and sulphur to be below 0.02, and manganese low. To be hardened in oil, through oil in water, or in water, at the manufacturer's discretion.

General Requirements

Each blade is inspected for size; each hardened and tempered blade is given a $\frac{3}{4}$-inch compression test and a striking test. One blade in each two hundred is given a $2\frac{1}{2}$-inch compression test, and if not satisfactory, others are tested or the entire lot is returned for further treatment, at the option of the manufacturer and inspector. After this, the blades are given the inspection mark and returned for finishing. The permissible variations in blade lengths are $\frac{1}{4}$ inch; other dimensions 0.010 inch, except rifle engaging device which must be within limits of + 0.002 or — 0.005 inch. The specifications for finish call for the blade to be sandblasted; the guard, handle, pommel, and catch heavily browned; the screws oil blackened, and the black walnut grips linseed-oil treated. After this, the blades are given tests for final finish, size, workmanship and physical tests.

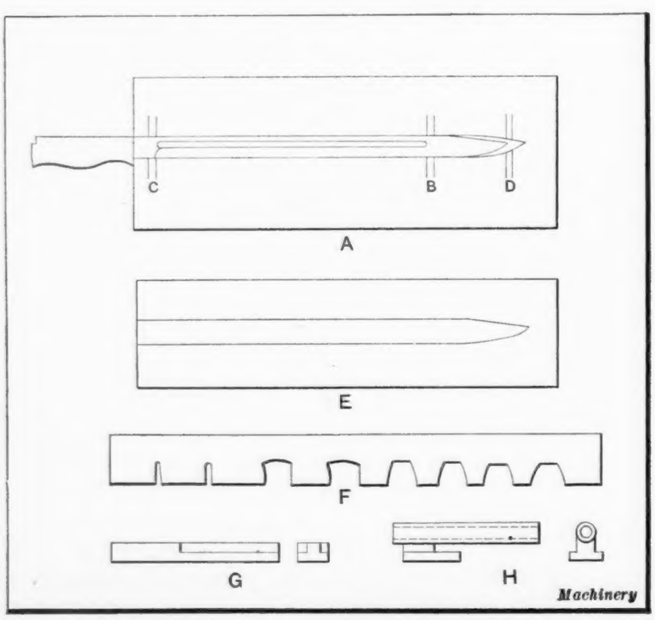

Fig. 2. Gages used in inspecting Lee-Enfield Bayonets

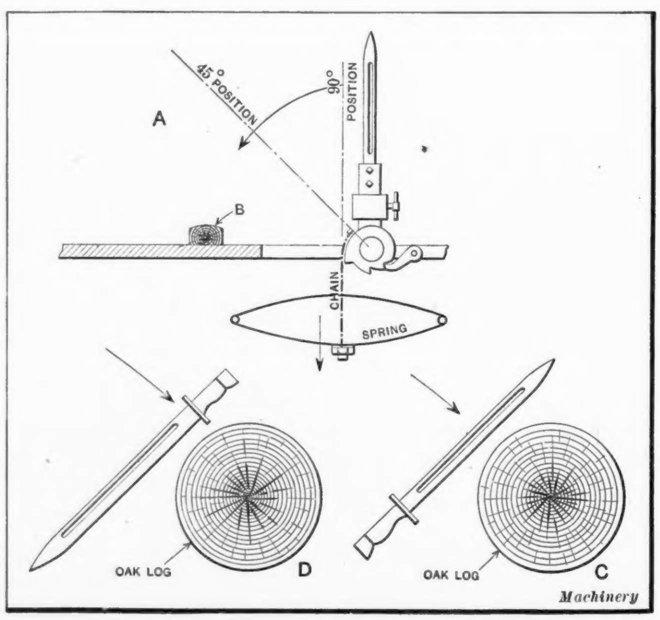

Fig. 3. (A) Whip Test Device. (C) (D) Final Acceptance Test

Description of Tests and Gages

The gages shown in Fig. 2 are representative of those used in the inspection of the bayonet. *A* shows a receiver gage for length of blade and length of groove. The maximum and minimum length of blade permissible are indicated by lines at *D*, while the limits on the grooves are indicated at *B* and *C*. *E* is another receiver gage for testing the width of the bayonet. There are two of these gages, one of maximum width which receives the blade freely, and one of minimum width which will not accept blades. The actual width of the blade is tested with a "feeler" 0.010 inch in thickness. The type of gage shown at *F* is for the purpose of determining the cross-section and general outline of the groove, guard, and the front side and end of the pommel.

Gage *G* is made in two sizes, one of which is for maximum size of pommel slot, and the other for minimum size. Gage *H* is a tube and plug gage for testing the alignment of pommel guards and blades by sighting through the tube. The tongued portion is slipped into the pommel slot in use. Straightness of blade is tested by sighting along the edge and back, perpendicular and parallel to both ends. This will disclose the slightest bend or twist in the blade.

Whip Test

A diagrammatic representation of the method used for testing the front and back edges of the bayonet blade is shown in Fig. 3 at *A*. In this test an oak block is used on which the blade strikes as indicated at *B*. The bayonet blade is held in a socket mounted on a shaft having at one end a ratchet and pawl provided with a suitable quick release. An elliptic spring is placed below the fixture and is connected by means of a chain to the collar on which the ratchet teeth are cut. As the ratchet is thrown out of engagement, the pull of the spring causes the holder and the bayonet to describe an arc of 90 degrees, the motion being arrested by the oak block against which the blade strikes. Two tests are made in this fixture, one with the bayonet held at 45 degrees and the other at 90 degrees, the 90-degree test being made against the oak block shown, while the 45-degree test is made on the iron plate with the oak block removed. The pull of the spring is from 17 to 19 pounds for the 90-degree test and from 9 to 12 pounds for the 45-degree test.

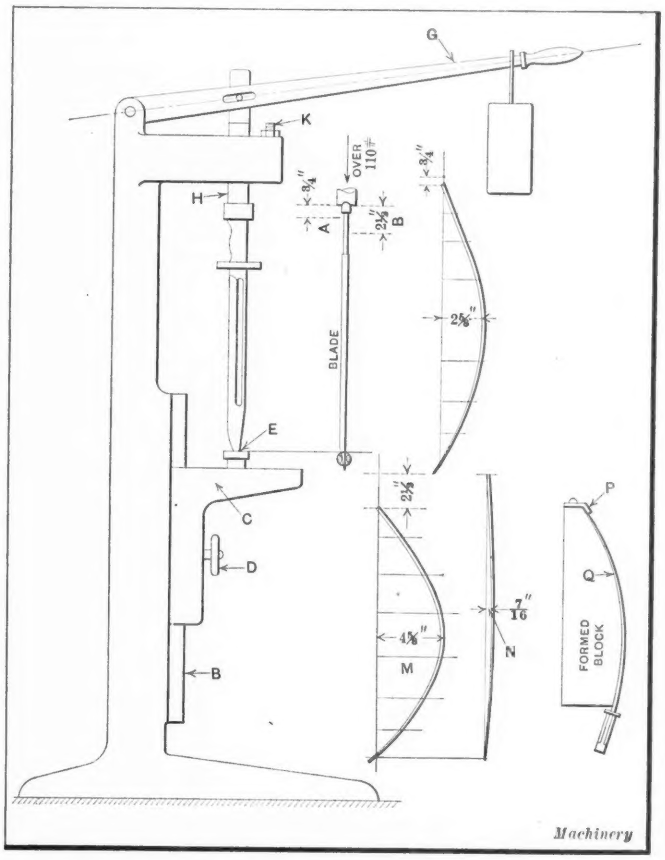

Fig. 4. Compression and Bending Tests

Broken blades are rejected after coming from this test and bent blades are returned for straightening and rehardening. The blades which have successfully passed the test are next taken to the compression test.

Compression Test

In making the test for compression of the bayonet blade, a special type of machine is used as indicated in Fig. 4. This machine consists of a standard, much like that of a small vertical drilling machine, carrying a vertical slide *B* on which an adjustable table *C* can be locked in any desired position by means of the locking screw shown at *D*. The spindle *H* is mounted so that it can be controlled by the lever *G*, and an adjustable stop *K* is provided to limit the vertical movement. In using this fixture, the bayonet is placed with its point in the cup shaped bushing *E*, while the spindle is brought down upon the pommel by the hand-lever. Sufficient pressure is exerted on the lever to compress the blade $\frac{3}{4}$ inch. After this it is examined for "set," returned to the testing machine, bent the other way, examined again for set, and if not bent is gaged for size.

The blade must raise 110 pounds from the compressed point and straighten itself under this load. This is a normal compression test, but in addition to this, one blade in every two hundred is given a $2\frac{1}{2}$-inch compression test as indicated at *M* in Fig. 4. When the blade is given this extra test, it must recover with a final set of not over 7/16 inch as shown at *N* or it will be rejected. If the bayonet passes this test satisfactorily, the entire lot is passed by the inspector. If unsatisfactory, another bayonet may be tried, and if this also does not pass inspection, the lot is returned for retreatment. The blade which is given the test is destroyed. The various diagrams shown in Fig. 4 represent the approximate curvature taken by the blade under the tests mentioned. The machine is covered with a stout wooden case during the testing, to protect the operator from flying fragments in case of breakage. This wooden case is provided with a door which is so arranged as to permit the removal of broken blades, and a small opening for inserting and removing the blades.

Bend Test

This is a hand test over a formed block which is curved to the same form as the curve obtained in testing under the machine. In this test the point of the blade is held under a suitably formed clamp *P* at the end of the block, and the blade is bent by holding the handle in the hand and pressing it around the form as indicated at *Q*. This is done after the wooden grips have been attached and does not require any great strength on the part of the operator. A wire screen is provided on this fixture to protect the operator in case of breakage. The object of this test is to throw a strain on the handle, which is softened during the brazing, and the slightest set is sufficient to cause a rejection of the blade.

Final Acceptance Tests

Before the blade is finally accepted, another test is made as indicated at *D* and *C* in Fig. 3. At this time the bayonet is completely finished. The blade is held by the operator and the handle is sharply struck against an oak log about 18 inches in diameter. Then the handle is grasped and the blade struck against the log. The front, back and sides of the blade are struck on the log during the test. The brazing of the guard is also tested as it is struck against the log.

Hardening Troubles

The testing of a military bayonet is extraordinarily severe. If the blade is made of minimum thickness, it fails to lift the weight of 110 pounds on the $\frac{3}{4}$-inch compression test, even though it does not set at this time. If the blade has not been sufficiently drawn in tempering, it snaps like glass under the test, while if it is drawn too much it sets. If, again, the forging heat is too high, the blade is ruined, and if the flame is sharp or oxodizing, the result is the same. As the shape of the bayonet and its section vary considerably, the blade tends to draw during the cooling, so that it bends both edgewise and sidewise.

The temperature at which a bayonet should be drawn is the same as that used for such wood cutting tools as axes, and is called an "axe blue." The high-carbon steel used in the bayonet is exceedingly sensitive to slight changes in hardening temperatures, and the tempering must be done very carefully in order to produce the desired results. The straightening must be done before the blades have become cold. In tempering, the use of a lead-tin mixture is likely to check the blade so that it will break under the test. The bayonet blade may be tempered by drawing it over an open flame, but this method requires long training and great skill.

The testing of a bayonet brings up a number of points in connection with the manufacture not ordinarily met with in other lines of mechanical work. The methods used in determining the physical characteristics of the steel after it has been put through the various processes of manufacture are of interest and illustrate clearly the problems with which the manufacturer has been confronted in making military equipment that conforms to government requirements.

* * *

REPAIRING A WATCH BALANCE STAFF

BY GUY H. GARDNER*

In passing a jeweler's establishment, all of us have seen through the window the watchmaker seated at his pygmy lathe, and have noted some points in which his work resembles ours. Many machinists, however, have carried their investigations no further than a casual glance, and such men may find something of interest in a description of one piece of watch repair work. First, I wish to say that the man whose methods I am about to describe is of the older generation, and employs simpler and fewer tools than many of his younger brethren, relying on his laboriously acquired manual skill to accomplish results which others attain by improved appliances.

For example, in the job he is about to begin, he makes no use of the slide-rest, though he has one safely wrapped in chamois skin in his bench drawer and often utilizes it for certain kinds of work. Just as his slide-rest is a miniature copy of our familiar lathe carriage, minus change-gear and feed-rod connections, many of his tools and appliances manifest a similarity to ours in all but size, though others have no counterparts in our trade, so far as I am aware. Our friend is called upon to repair a watch of foreign make, which has been injured by a fall. He finds, on examination, that both pivots are broken from the balance staff.

Fig. 1 shows the staff with both pivots intact. The first lathe work consists of the removal of the balance, the other attachments of the staff being removed by other means. As may be seen, the balance is held by the riveting or "heading over" of the metal above it. This might be cut away in the lathe, but the watchmaker knows the danger of marring or springing the delicate balance, and adopts the preferable method of turning off the shoulder *A* on which the balance rests. Now, if the timepiece were of American make, he would simply insert a ready-made staff, obtained from the watch factory, which would be so nearly a perfect fit as to require, at most, only a touch of a lap at the points where exactness of size is needed, as these are sometimes a trifle large. Moreover, if but one pivot were damaged, he might "chuck" (as we should call it) a hole in the broken end of the staff and drive in a plug, the projecting part of which he would turn to the dimensions of the missing pivot.

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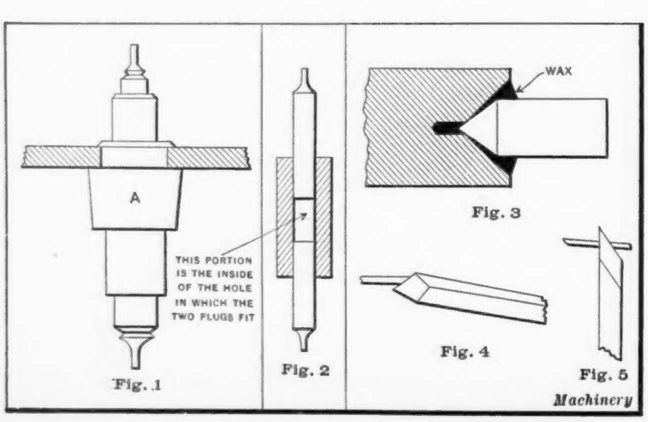

Figs. 1 to 5. Successive Steps in repairing a Watch Balance Staff

In the present case, however, he proceeds to make a new staff. First he needs to know the approximate diameter, which he judges by inspection, and also the exact length; this last dimension must be accurately determined because, as anyone may see by looking into the back of a watch, the ends of the pivots abut against "cap jewels." To obtain this measurement he uses a tool shown in Fig. 2, in which two rods with ends like pivots, slip friction-tight in a sleeve.

The dimension thus found looks to be about ¼ inch, and if I may anticipate a little, the micrometer showed the over-all length of the finished staff to be 0.2395 inch. The raw material for the new staff is a bit of drill rod, which is heated in the alcohol lamp flame to a cherry red, quenched in cotton-seed oil and drawn to a light blue. This is gripped in a split chuck, cut off to length and one end is pointed like a lathe center.

Now, as this workman does not think a split chuck quite good enough for accurate work, an opinion once common among watch repairers, he uses the affair shown in Fig. 3, which he calls a "wax chuck." It consists of a piece of round brass rod in which he has bored a hole while the piece was held in the lathe. In this chuck he places the conical end of his balance staff blank; fastens it with "wax" (a compound whose basis is shellac), softening the wax by the heat of the lamp flame; and trues up the piece to center by pressing against it, as it rotates, with a bit of wood resting on the T-rest. When the wax is cool he proceeds to turn the projecting part to within about 0.001 inch of its finish dimensions, and then reverses it in the "wax chuck" and does the same to the other half.

Here we note a departure from the usual machine shop method of using the square graver, which is the only lathe tool employed on this job. In roughing out the staff he holds the tool as shown in Fig. 4, with its axis nearly parallel with that of the work, the same position being used in slightly rounding the pivot ends; but for taking the "finish chip" he adopts the position shown in Fig. 5, taking a shaving that is hardly visible without the eye-glass under which all his work is done. To form what he calls "the cone" at the base of each pivot, the graver (held as in Fig. 4) is given a rolling motion, its top being rotated toward the workman.

Now all that remains is to reduce the various "fits" to their proper dimensions by means of a lap carried in a device similar to a toolpost grinder, which is driven from the countershaft on the back of the bench. The rollers, hairspring collet and balance are put in place, and the riveting for the last-named is done by a "staking tool," which is somewhat like an arbor press except that it is perhaps 5 or 6 inches tall, and a hundred different "punches" take the place of the ram, being driven by light taps of a brass mallet. After the watch is put together, the final "operation" is a demand for $2, no charge being made for the information his customer has acquired concerning a trade closely resembling his own in some respects, yet radically different in its methods.

* * *

VANADIUM STEEL FOR AEROPLANES

One of the most recent and interesting applications of vanadium steel is in the new armored aeroplanes known as "battleplanes," built for the United States Army by the Sturtevant Aeroplane Co. This new type of flying machine possesses many novel features, but chief among them is the fact that the entire craft, wings and all, is built of vanadium steel. On the first model in which steel was used, the saving in weight as compared with the wooden construction was not great, but it was soon found that by careful refinements in details, the sections could be greatly reduced without sacrifice of strength, and in subsequent models the weight has been reduced from 25 to 30 per cent. The vanadium steel used in the framework is cold-rolled stock. The sheet steel used for the wings is also cold-rolled, and in addition vanadium steel wire is extensively used.

AN OPPORTUNITY FOR THE TOOLMAKER

BY F. B. JACOBS*

Toolmakers as a class are sometimes inclined to be dissatisfied with their environment. Just why this should be is a question; nevertheless the fact remains that a fair percentage of all who are engaged in manual labor have a secret ambition to become skilled in a higher calling. Certain shrewd business men who are keen students of human nature are well aware of this fact—hence the existence of the correspondence schools that are not at all backward in claiming to teach practically everything. If the toolmaker is possessed of a fair amount of ambition and has a yearning for something better than daily toil at manual labor, there are several avenues open to him, and the object of this article is to touch briefly on the subject of tool designing and the toolmaker's chances of succeeding in this line.

Many of the younger toolmakers of today have a vague idea that tool designing is a branch of drafting-room practice that has existed for as long a period as toolmaking, but this supposition is erroneous. Twenty-five years ago, as any gray-haired toolmaker today can testify, tool designing as practiced at present was almost unknown. In those days the toolmaker himself was the designer, planning his work as he went along. To be sure, he sometimes had a pencil sketch to guide him, but the greater part of the real designing originated in his brain, and to him alone is due the credit for many of the labor-saving ideas of the present. The patternmaker, too, often had a finger in the pie, so to speak; he was frequently given a finished part, about which he leisurely proceeded to build a pattern. This often resulted in heated arguments in cases where the finished jig did not come up to requirements—a sort of three-cornered debate between the "old man," the toolmaker and the patternmaker. Eventually the toolmaker rebuilt the jig, during which time he frequently indulged in a few far from complimentary remarks concerning patternmakers who thought they knew how to design jigs.

Origin of Tool Designing

This happy-go-lucky manner of designing jigs may have been satisfactory twenty-five years ago when present-day reproduction of machine parts was in its infancy. At that time, however, there were a very few concerns, chiefly shoe machinery manufacturers, who employed tool designers, and it was among them that our present methods of tool designing originated. The tool designing, such as it was, fell to the lot of the ordinary draftsman whose knowledge of the practical application of special tools for the rapid duplication of machine parts was almost nil. To be sure, many became proficient through dint of close application, but the manufacturer who occasionally needed a few tool designers had to go through the slow process of developing them from the material that was to be had. Practical shop men were almost unknown in the drafting-room in those days for two reasons: First, there was a deep-rooted prejudice against the man who wore overalls—he was looked upon as a common laborer who must not presume to rise above his station in life. Again, the toolmaker's wages were generally higher than the draftsman's, thus the drafting-room offered small inducement to the toolmaker.

The college-bred man was often employed in the drafting-room. When his college days were over, he waited for a few months "to consider the lucrative offers that eventually would come his way." The lucrative offers failing to materialize, he began to look for a job, to state the fact in plain English, and as the rudiments of drafting was the only practical knowledge he possessed, to the extent of turning it into bread and butter, he became a draftsman. It is not the writer's intention to discredit college-trained men—far be it from such—but at the same time we cannot help but realize that their technical training should have fitted them for something far better paying than working at the drafting board.

The old regime, however, is passing, and with it the jealously guarded veil of secrecy that surrounded knowledge of various practical subjects. One reason for this is that present advantages for education are so plentiful that it is possible for the ambitious man to obtain knowledge on a diversity of subjects at small cost. Heretofore, special education on any subject was reserved for the favored few who, through a trick of fate, happened to be born in fortunate circumstances.

Demand for Tool Designers

Without a doubt, the greatest impetus given to tool designing came through the phenomenal growth of the American built automobile. When we consider that it takes hundreds of jigs, to say nothing of other fixtures and special tools, to put a new model on the market, and that this is often accomplished in ninety days or less at a cost of approximately one hundred thousand dollars, for the ordinary type of six-cylinder car, we begin to realize the importance of tool designing. With the new order of things came the demand on a large scale for efficient men who could design tools; thus the way was opened for the toolmaker to step from a productive to a creative line of work. His knowledge of tools, in general, is a valuable asset that is never possessed by the purely theoretical man. Again, experience has taught the toolmaker just how each part of a jig or fixture should be designed with the view of lessening machine work whenever possible. The time-honored expression: "Oh, well, I guess the toolmaker can machine it somehow," is no longer tolerated. The present-day tool designer is supposed to know—he is no longer allowed to shift responsibility to another's shoulders.

When the writer speaks of a toolmaker, the all-around man is referred to—not the man who, because he has made a few reamers or jig bushings,, styles himself a toolmaker. The question naturally arises: "How is a man who has never made a working drawing to fit himself for a position as tool designer?" In the first place, the all-around toolmaker has a complete practical knowledge of special tools, that is, if he has traveled to any extent and has kept his eyes open, and it can be said to his credit that he usually has. Again, having worked to drawings for several years, he knows how to read them. As a matter of fact, the toolmaker will often spot a wrong projection or an incorrect over-all dimension that had escaped the draftsman and the checker.

How to Learn Tool Designing

To come to the direct subject: How is the toolmaker to learn mechanical drafting? There are several ways. Perhaps the most convenient method is to study the subject at home from text-books. This has the disadvantage, however, that the student has no one to point out his errors—he has to dig out everything for himself. In our large cites, evening schools teach the subject, or at least the rudiments of it, to all who care to enroll. This is a very good method, as a competent instructor is always at hand to point out mistakes. The majority of home students, however, study the subject through correspondence courses, as they are not expensive, when the knowledge gained is taken into consideration, and the instructors are competent.

There seems to be a certain amount of prejudice against correspondence schools, especially among those who are ignorant of them, but if we investigate the matter we will find that there is seldom just cause for criticism. The writer does not mean to infer that every Tom, Dick, and Harry can become proficient at drafting through correspondence teaching, for of course the human element plays the all important part. However, he does not hesitate to state most emphatically that any bright young man with a leaning toward drawing and a determination to succeed can master the principles of the subject through home study. Drafting is largely a matter of manual skill; hence it takes a long time and constant practice to become a rapid and efficient workman.

The toolmaker who wishes to become a tool designer must also master the subject of trigonometry. Now, as a matter of fact, this study is not half as formidable as its name implies: in fact, any man who is mathematically inclined should become fairly proficient in a few months' study. Briefly described, trigonometry is the science of measuring

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the sides and angles of triangles and ascertaining the relations between them by certain parts which are given, namely: the tangent, cotangent, sine, cosine, secant and cosecant. A knowledge of these parts, together with the tables of trigonometric functions, such as are found in MACHINERY'S HANDBOOK, is all that is required to solve the ordinary right-angle problems that confront the tool designer. A working knowledge of square root is also quite essential. Cube root, however, is seldom used by the tool designer, as he rarely has occasion to deal with the third power of numbers. As a matter of fact, ninety per cent of the tool designers of today cannot solve problems in cube root offhand because they are rusty on the subject owing to lack of practical application. A knowledge of algebra and logarithms sometimes proves of value to the tool designer, but this is not absolutely essential. The writer's advice to the embryo tool designer is to leave these subjects strictly alone until he has mastered ordinary arithmetic and simple trigonometry; otherwise confusion is sure to result, or, to use the shop man's favorite expression, he will get completely "balled up."

How is the toolmaker to obtain employment at tool designing after he has become proficient in drawing and mathematics? Now this is where the real rub comes in. About the first question invariably asked is: "What experience have you had?" This is where the man must work out his own salvation—it is up to him and to him alone. As a matter of fact, there are only two avenues open: the toolmaker must either state that he is an experienced draftsman, or say frankly that he has had no practical drafting-room experience.

The better way is for the aspirant to stick to the truth and endeavor to convince the chief draftsman that he understands the subject of tool designing and only wants an opportunity to prove his worth. Sooner or later he will find some one who will be willing to take a sporting chance and try him out. To be sure, he will have to start at a low rate, but after he has had a year or so of that mystic "experience" he will gradually advance as he acquires practical knowledge.

There are many who claim that the shop man never makes a good tool designer, but there is no sound argument to substantiate this claim. The fact is that about fifty per cent of the tool designers of the present are practical toolmakers. Now, what man has done he can do again, thus it is up to the toolmaker to improve his spare time. He must realize that no one is coming to offer him a better position on a silver platter, so to speak; it all depends on himself. He must first fit himself for advancement and then devote all his energies to attaining success.

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SHELBY STEEL TUBING FOR DIFFERENTIAL BEARINGS

Steel tubing is rapidly taking the place of solid stock that has been bored out, for various manufacturing purposes. This is especially true in the case of hollow shafts, bushings,

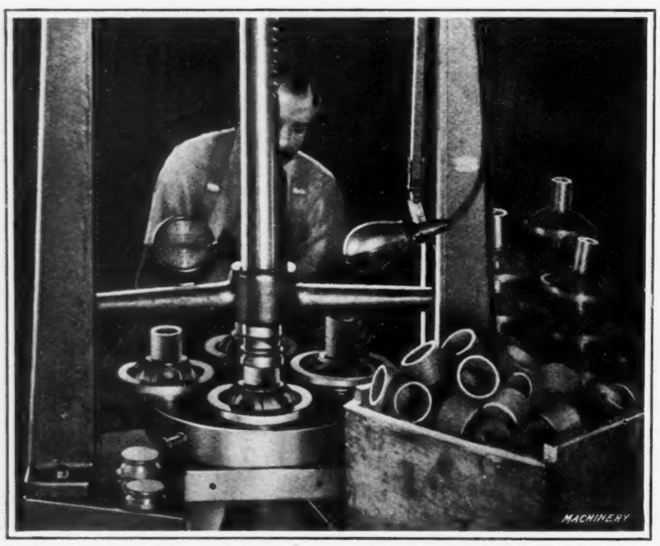


Fig. 1. Forcing Bushings into Place in Differential Gear-case

Fig. 2. Boring Tubing for Bushings

sleeves, etc., that are made to close dimensions, as the lengths of tubing can be used as blanks to be machined to the required accuracy. The convenience of being able to obtain tubing of varying external and internal diameters and different thicknesses of walls is leading to its use for many products that were formerly made from solid stock with a great expenditure of machining time and waste of stock.

The Brown-Lipe-Chapin Co., Syracuse, N. Y., uses Shelby steel tubing for making bushings for differential gear housings. The illustrations show how the tubing is used for this purpose. As shown in Fig. 2, it is first cut to lengths long enough to make the bushings. Then these pieces are bored out to give the proper internal diameter for the force fit that must hold them to the differential gear-case. They are also turned on the outside in order to remove the scale and bring them to approximately the finished diameter before being hardened.

After the bushings have been hardened, they are forced over the hubs on the differential cases on a regular power forcing press, as shown in Fig. 1. The gear-cases with the bushings in place then go to the grinding machine and are ground on the bushing surfaces, enough metal being removed to give the required finish and diameter. It will be readily appreciated that this method of using pieces of tubing for these bushings results in lowering the manufacturing cost considerably.

C. L. L.

* * *

AVIATION AS A SPORT

Aviation as a sport has not yet attracted many in America, but after the European war it is likely to develop rapidly and become very popular. The aeroplane has been developed to a stage that few fully appreciate. Speeds of 100 miles an hour are common, and 120 to 130 miles are not exceptional. Devices for maintaining equilibrium contribute to safety, and dependable engine and wing construction has made aviation almost as safe as automobiling. Not only will aviation become a sport, but eventually the aeroplane will become a recognized means of commerce for carrying mail, express packages and high-class freight. One of the devices for making aviation more popular as a sport is the Turner aviaphone, which makes conversation possible in mid-air. This instrument consists of a helmet or cap with a telephone transmitter that is worn by each occupant of the car. Without such means it is practically impossible for the pilot and his passengers to converse while in the air owing to the noises made by the propeller and engine, but with the aviaphone, conversation is easy; this contributes to the comfort, enjoyment and safety of aviation.

THREAD MILLING IN THE LATHE

BY E. T. SPIDY*

The unusual demand for machinery for threading shrapnel and high-explosive shells which has existed for the past year and a half has made it necessary to devise special means of thread milling, and the following article describes the way in which several engine lathes were successfully adapted for this kind of work so that an output was secured equivalent to that of machines especially designed for thread milling. While the description applies to the milling of threads in shells, the same method and equipment could be used in thread milling a variety of other classes of work.

The engine lathes used were standard 18-inch machines that were in good condition and had lead-screws of a high degree of accuracy. One of the machines is shown set up in Fig. 1, and the chuck in which the work is held is shown in detail in Fig. 2. The chuck consists of a hollow body which is secured onto the lathe spindle and finished after being set up in position. The cone on the inside provides for centering one end of the shell, and tightening the nut at the front brings the shell into accurate alignment with the lathe spindle. The overhanging weight of the chuck is supported by a steadyrest of the form shown at *A* in Fig. 3; the steadyrest has a three-point bearing with brass screws to provide means of compensating for wear.

The cross-slide on the lathe carriage was removed and a special fixture *B*, Fig. 3, was substituted to carry the milling cutter. The thread milling fixture is provided with an adjustable stop for setting it to mill threads of the required depth without making measurements. The milling spindle is driven by a 2½-inch belt, at a speed of 200 revolutions per minute, power being taken from a special pulley on the countershaft, fitted with a belt shifter. One machine had this milling fixture attached to the cross-slide so that the turret and tools were retained for cutting the recess in the base of the shell preparatory to milling the thread; but experience gained with both types of equipment showed that the best results were obtained by having the machines devoted entirely to the thread milling operations.

The lead-screw and regular locking clamp on the carriage are used to transmit feed to the cutter, and a handwheel was attached to the end of the screw to facilitate taking up backlash in the clamp. Suitable pulleys were arranged on the countershaft to drive the headstock through the back-gears at a speed of 1½ revolution per minute. In cutting a thread in the base recess, the shell is placed in the chuck and the screw tightened. The milling cutter is next set in motion and run into the recess by the carriage handwheel, after which the lead-screw nut is locked and the cutter drawn close to the bottom of the recess by turning the handwheel at the end of the lead-screw.

* Address: 108 Walnut St., Winnipeg, Manitoba, Canada.

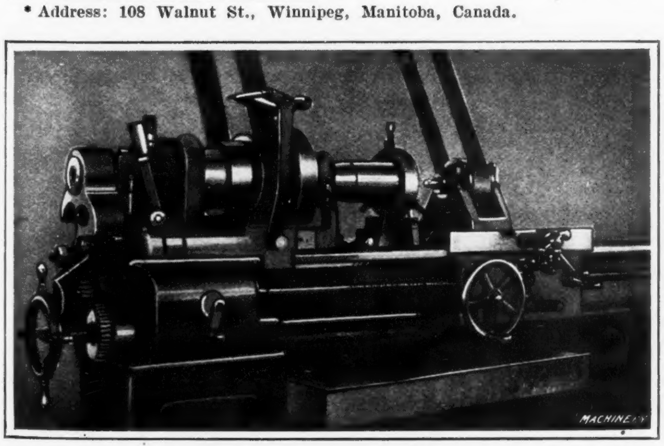


Fig. 1. Engine Lathe equipped with Special Fixture for performing Thread Milling Operation on Shells

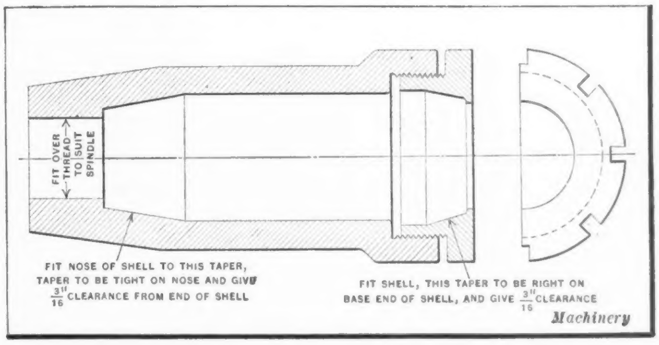


Fig. 2. Type of Chuck used for holding Shell on Machine shown in Fig. 1

When the bottom of the recess is reached, the handwheel is reversed until the backlash has been taken up, after which the feed is started and the milling cutter fed into the work to the correct depth. The headstock and shell are now started rotating by means of a second belt shifter on the countershaft, and one complete revolution of the work finishes the milling operation. The cutter is then drawn out of the recess and the shell removed from the chuck. The entire operation does not take two minutes from the time the shell is picked up from the floor until it is put back with the thread milled. The same method is applicable in milling the thread in the nose of the shell except that the chuck must be of a slightly different shape. The cost of adapting a lathe for handling thread milling operations in this way is small, and the lathe may be easily changed back for handling the usual classes of lathe work. This may be of suggestive value to shops where thread milling machines are not available.

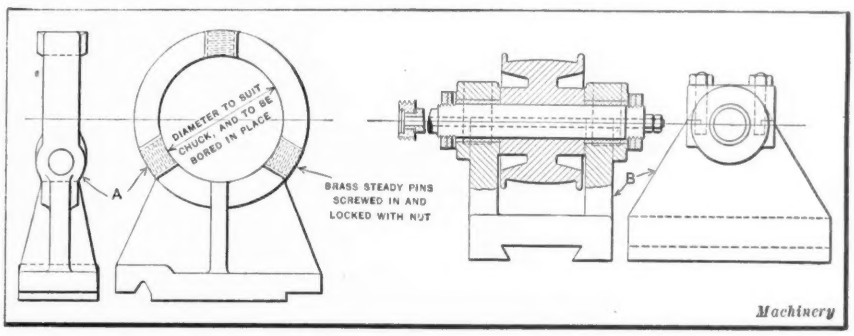


Fig. 3. Steadyrest for supporting Work; and Sectional View through Milling Fixture

* * *

SCLEROSCOPE AND BRINELL HARDNESS TESTS OF CUTTING TOOLS

In a paper read before the Iron & Steel Institute, Sheffield, England, Prof. J. O. Arnold states that after a prolonged series of experiments it has been clearly determined that the Brinell and scleroscope numbers registered by hardness tests do not give any approximate measurement as to their cutting efficiency in the lathe. It was also determined that the efficiency of a lathe tool depends entirely on the thermal stability of the simple or compound hardenites in the hardened steel. A Brinell or scleroscope test is a valuable means of rapidly determining the elasticity of structural steels, but is absolutely valueless for making estimates of the varying thermal stabilities of the hardenites which mainly determine lathe efficiency in high-speed cutting tools. One peculiar condition found in making these tests was that with the various types of tools tested, the maximum efficiency was obtained at the second grinding, and when these tools were run with the point at a red heat the breakdown took place about five minutes after the point began to get red-hot.

* * *

"ESCO" GROOVING MACHINE

The selling rights of the "Esco" grooving machine described in the June number have been turned over by the Walco Mfg. Corporation, Providence, R. I., to F. G. Street, 60 Broadway New York City.

STUDS AND NUTS FOR JIG WORK*

STANDARDS USED BY GENERAL ELECTRIC CO.

BY R. F. POHLE†

STUDS are used in jig design for locating work with holes in it. Table I shows a recommended form of stud. C-washers, Table III, are used in connection with threaded studs for clamping. When in use, the work is passed over the head of the clamping screw or nut. The C-washer is placed on the work and the screw or nut tightened. This form of clamping device is often replaced by so-called "wrench nuts" and "slip nuts."

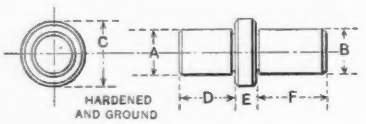
* The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards have been developed for the company by R. F. Pohle, who is in charge of the tool designing department.

† Address: General Electric Co., Lynn, Mass.

Nuts Used in Jig Design

A number of special nuts are used in jig design. The wrench nut, Table V, is a rapid clamping device giving excellent service. Its use for quick clamping is almost unlimited. In cases where the work is passed over a stud and usually clamped by a C-washer under an ordinary nut, it will be found much better to use the wrench nut than the C-washer. Slip nuts are made in three styles, as shown in Tables VII, IX, and XI. They are used for purposes similar to those for

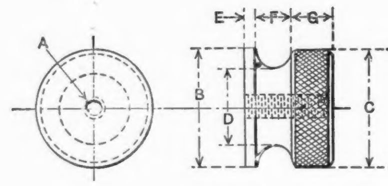
TABLE I. COLLAR STUDS



A	B	C	D	E	F
0.251	0.249	½	½	3/16	¼ to ⅝
0.3135	0.3115	9/16	½	3/16	5/16 to 11/16
0.376	0.374	⅝	⅝	3/16	⅜ to ¾
0.4385	0.4365	11/16	⅝	3/16	7/16 to 13/16
0.501	0.499	¾	⅝	¼	½ to ⅞
0.5635	0.5615	⅞	⅝	¼	½ to ⅞
0.626	0.624	1	¾	¼	½ to 1 1/16
0.6885	0.6865	1⅛	¾	¼	⅝ to 1 3/16
0.751	0.749	1¼	⅞	¼	⅝ to 1⅜

Machinery

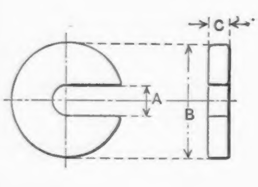
TABLE II. THUMB NUTS



A Diameter and Number of Threads per Inch	B	C	D	E	F	G
No. 10—32	⅝	⅝	⅜	1/16	3/16	¼
No. 14—24 or 5/16—18	13/16	13/16	½	3/32	¼	5/16
⅜—16 or 7/16—14	1	1⅛	11/16	⅛	5/16	7/16
½—13	1¼	1½	⅞	5/32	⅜	9/16
⅝—11 or ¾—10	1½	1¾	1 1/16	3/16	⅜	11/16

Machinery

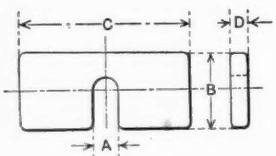
TABLE III. C-WASHERS



A	B	C
7/32	½ to 1¼	⅛
9/32	⅝ to 1⅜	⅛
11/32	1 to 1¾	3/16
13/32	1⅛ to 1⅞	3/16
15/32	1¼ to 2	¼
17/32	1¼ to 2½	¼

Machinery

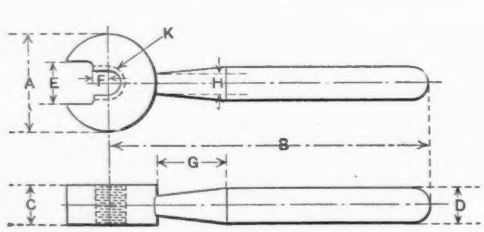
TABLE IV. STRAP WASHERS



A	B	C	D
9/32	1	2 to 3¼	¼
9/32	1	3½ to 4	5/16
13/32	1¼	2½ to 4	5/16
13/32	1¼	4¼ to 5	⅜
17/32	1½	3 to 4½	⅜
17/32	1½	5 to 6	½
25/32	2	4 to 5¾	½
25/32	2	6½ to 8	¾
1 1/32	3	6 to 9	¾
1 1/32	3	10 to 12	⅞

Machinery

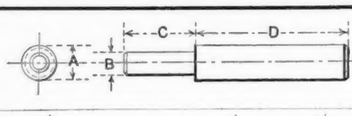
TABLE V. WRENCH NUTS



A	B	C	D	E	F	G	H	K Diameter and Number of Threads per Inch
¾ to ⅞	2	¼	¼	5/16	¼	¼	3/16	No. 14—24
1 to 1⅛	2	5/16	5/16	5/16	¼	¼	3/16	No. 14—24
¾ to ⅞	2	¼	¼	⅜	¼	¼	3/16	5/16—18
1 to 1⅛	2	5/16	5/16	⅜	¼	¼	3/16	5/16—18
1⅛ to 1¼	3¼	⅜	⅜	7/16	⅜	¾	¼	⅜—16
1½ to 1¾	3¼	7/16	7/16	7/16	⅜	¾	¼	⅜—16
1½ to 2¼	4⅛	½	½	9/16	½	⅞	5/16	½—13
2 to 3	5	⅝	½	11/16	⅝	1	⅜	⅝—11
2½ to 3½	5¾	¾	⅝	13/16	¾	1	½	¾—10
2½ to 3½	6¼	¾	¾	15/16	¾	1	½	⅞— 9
2¾ to 3¾	6⅞	⅞	⅞	1⅛	⅞	1¼	⅝	1— 8
3 to 3¾	7½	1	⅞	1¼	⅞	1½	⅝	1⅛— 7
3½ to 4	8	1⅛	⅞	1⅜	⅞	1½	¾	1¼— 7

Machinery

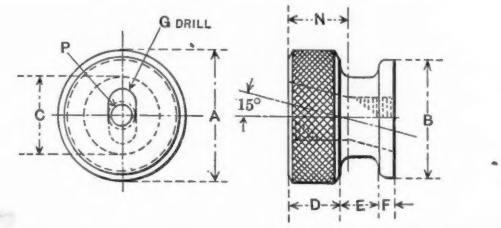
TABLE VI. SHOULDER STUDS



A	B	C	D	A	B	C	D
5/16	0.1885	¼	3/16 to 5/16	9/16	0.4385	⅞	1¾ to 2¼
5/16	0.1885	5/16	⅜ to ½	9/16	0.4385	1	2½ to 3
5/16	0.1885	⅜	9/16 to 11/16	9/16	0.4385	1¼	3½ to 4
5/16	0.1885	7/16	¾ to ⅞	⅝	0.501	⅞	¾ to 1
5/16	0.1885	½	15/16 to 1⅛	⅝	0.501	1	1½ to 2
⅜	0.251	¼	¼	⅝	0.501	1¼	2½ to 3½
⅜	0.251	⅜	⅜ to ½	⅝	0.501	1½	4 to 5
⅜	0.251	½	⅝ to ¾	¾	0.501	⅞	1 to 1½
⅜	0.251	⅝	⅞ to 1⅛	¾	0.501	1	2 to 3
⅜	0.251	¾	1¼ to 1½	¾	0.501	1¼	3½ to 4½
7/16	0.3135	⅜	⅜ to ½	¾	0.501	1½	5 to 6
7/16	0.3135	½	⅝ to ⅞	⅞	0.6265	1	1¼ to 2½
7/16	0.3135	⅝	1 to 1¼	⅞	0.6265	1¼	3¼ to 4¾
7/16	0.3135	¾	1⅜ to 1⅝	⅞	0.6265	1½	5½ to 7
7/16	0.3135	⅞	1¾ to 2	1	0.7515	1	2 to 4¼
7/16	0.3135	1	2¼ to 2½	1	0.7515	1⅜	5 to 5¾
½	0.376	⅝	½ to ¾	1	0.7515	1¾	6½ to 8
½	0.376	¾	1 to 1¼	1¼	1.0015	1¼	3 to 4
½	0.376	⅞	1½ to 2	1¼	1.0015	1½	5 to 6
½	0.376	1	2¼ to 2¾	1¼	1.0015	1⅞	7 to 9
½	0.376	1¼	3 to 3½	1½	1.1265	1½	4 to 6
9/16	0.4385	⅝	½ to ¾	1½	1.1265	2	7 to 10
9/16	0.4385	¾	1 to 1½	....	....	....	....

Machinery

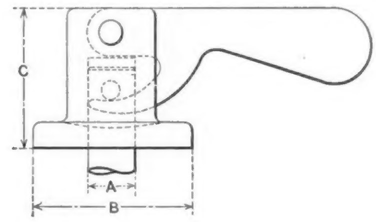
TABLE VII. KNURLED SLIP NUTS



A	B	C	D	E	F	G	N	P Diameter and Number of Threads per Inch
3/8	5/16	7/32	5/32	3/32	1/16	No. 37	5/32	No. 3—56 or 48
7/16	3/8	1/4	3/16	3/32	3/32	No. 31	3/16	No. 4—48 or 36
7/16	3/8	1/4	3/16	1/8	1/8	No. 25	7/32	No. 6—40 or 32
1/2	7/16	5/16	3/16	3/16	1/8	No. 13	1/4	No. 8—36 or 32
9/16	1/2	3/8	7/32	1/4	5/32	No. 3	5/16	No. 10—32 or 30
5/8	9/16	7/16	1/4	5/16	3/16	B	3/8	No. 12—28 or 24
7/8	3/4	5/8	5/16	3/8	3/16	9/32	7/16	No. 14—24 or 1/4—20
1 1/16	15/16	11/16	3/8	7/16	3/16	11/32	1/2	5/16—18
1 1/8	1	3/4	3/8	7/16	3/16	27/64	9/16	3/8—16
1 7/8	1 1/2	1 1/8	1/2	1/2	1/4	9/16	5/8	1/2—13

Machinery

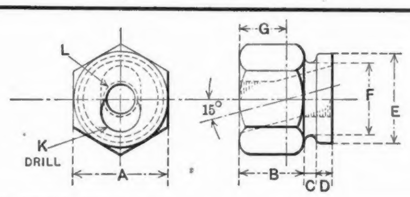
TABLE VIII. CLAMPING CAPS



A	B	C	A	B	C
3/8	1	1	7/8	3	1 9/16
3/8	1 3/8	1 1/16	1	2 1/4	1 1/2
1/2	1 1/4	1 5/16	1	2 3/4	1 9/16
1/2	1 3/4	1 5/16	1	3 1/4	1 9/16
5/8	1 1/2	1 3/8	1 1/4	2 1/2	1 15/16
5/8	2	1 3/8	1 1/4	3 1/4	1 15/16
5/8	2 1/2	1 7/16	1 1/4	4	2
3/4	2	1 9/16	1 1/2	3	1 7/8
3/4	2 1/2	1 9/16	1 1/2	4	1 7/8
7/8	2	1 1/2	1 1/2	5	2
7/8	2 1/2	1 1/2			

Machinery

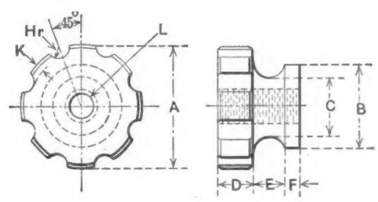
TABLE IX. HEXAGON SLIP NUTS



A	B	C	D	E	F	G	K	L Diameter and Number of Threads per Inch
3/4	9/16	1/8	3/16	11/16	9/16	7/16	9/32	No. 14—24
3/4	9/16	1/8	3/16	11/16	9/16	7/16	9/32	1/4—20
7/8	11/16	1/8	3/16	13/16	11/16	1/2	11/32	5/16—18
1	11/16	1/8	3/16	15/16	13/16	1/2	27/64	3/8—16
1 1/2	3/4	1/4	1/4	1 7/16	1 1/8	5/8	9/16	1/2—13
1 3/4	1 1/8	1/4	3/8	1 11/16	1 3/8	7/8	11/16	5/8—11
2	1 3/8	1/4	3/8	1 15/16	1 5/8	1	13/16	3/4—10
2 1/4	1 1/2	3/8	1/2	2 3/16	1 7/8	1 3/16	31/32	7/8—9
2 1/2	1 5/8	3/8	5/8	2 7/16	2	1 5/16	1 1/8	1—8

Machinery

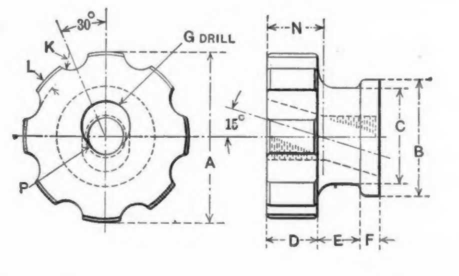
TABLE X. HAND NUTS



A	B	C	D	E	F	H	K	L Diameter and Number of Threads per Inch
1 5/8	1 1/4	15/16	9/16	5/16	1/8	1/4	1/8	1/2—13
2 1/8	1 1/2	1 1/16	11/16	1/2	3/16	5/16	3/16	5/8—11
2 1/8	1 1/2	1 1/16	11/16	1/2	3/16	5/16	3/16	3/4—10
2 1/2	1 3/4	1 1/4	3/4	11/16	3/16	3/8	1/4	7/8—9
2 3/4	2	1 1/2	13/16	11/16	1/4	3/8	1/4	1—8
2 7/8	2 1/8	1 5/8	7/8	3/4	1/4	3/8	1/4	1 1/8—7
3 1/8	2 1/4	1 3/4	1	3/4	5/16	7/16	5/16	1 1/4—7

Machinery

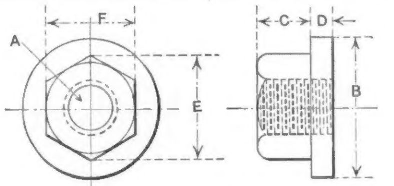
TABLE XI. FLUTED SLIP NUTS



A	B	C	D	E	F	G	K	L	N	P Diameter and Number of Threads per Inch
2	1 3/4	1 3/8	5/8	7/8	1/4	11/16	3/16	3/32	7/8	5/8—11
2 1/4	2	1 5/8	11/16	15/16	3/8	13/16	3/16	1/8	1	3/4—10
2 7/8	2 3/8	2	13/16	1 3/16	3/8	31/32	1/4	3/16	1 3/16	7/8—9
3	2 5/8	2 1/4	7/8	1 3/8	3/8	1 1/8	1/4	3/16	1 5/16	1—8

Machinery

TABLE XII. FLANGED NUTS



A Diameter and Number of Threads per Inch	B	C	D	E	F
5/16—18	13/16	3/8	1/8	11/16	19/32
3/8—16	15/16	3/8	1/8	51/64	11/16
7/16—14	1 1/16	7/16	1/8	29/32	25/32
1/2—13	1 3/16	1/2	1/8	1	7/8
5/8—11	1 7/16	5/8	1/8	1 7/32	1 1/16
3/4—10	1 11/16	3/4	3/16	1 7/16	1 1/4
7/8—9	2	7/8	3/16	1 21/32	1 7/16
1—8	2 1/4	1	1/4	1 7/8	1 5/8

Machinery

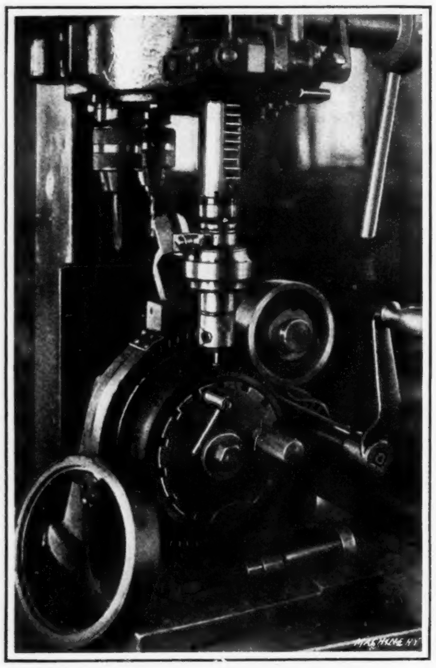
which the wrench nut is employed, but are applicable to work of smaller dimensions, or where it is not possible to obtain the required swing for the handle of the wrench nut. The clamping cap, Table VIII, is used similarly to the wrench nut and slip nut, but is only employed when the other forms cannot be used, because it is more expensive to make.

The standards for jig details that are given in this and preceding articles will, no doubt, be found valuable by designers of jigs and fixtures, because the tabulated arrangement saves the designer the trouble of deciding upon proper proportions in each case, and insures uniformity throughout the whole line of jig and fixture designs.

ATTACHING FIBER FACING TO A FRICTION RING

To mount a tough, springy strip of sheet fiber on the face of a friction ring is one of the meanest jobs that come to a machine shop. It is hard to make the fiber lie flat against the face of the ring long enough to drill and tap the holes for the attaching screws. These friction rings (one of which is shown at the left-hand side of the illustration) are about 8 inches diameter with a 1-inch face. The old method of doing the work was to clamp one end of the strip in position, drill and tap the first hole, put in the screw and then move the clamp to a second location and repeat the operation. It will be seen that this was a troublesome job, as sixteen screws are used to attach one facing, and not over three rings could be faced per day of ten hours.

At the plant of the New Britain Machine Co., New Britain, Conn., through whose courtesy the illustration is shown, the job is handled in a Turner turret drill. On the table of this machine is a simple fixture, consisting of a drum over which the friction ring fits and an indexing fixture to permit of turning the ring successively to the sixteen positions required for drilling. After the first hole has been drilled, tapped and the screw entered, the fiber strip is wound around the drum and under the roll that may be seen at the right. This keeps the fiber strip against the disk, and it is unnecessary to use clamps that obstruct the working space. By means of the crank on the pinion shaft, the pinion and the drum to which it is geared are rotated and the indexing is performed.



Attaching a Fiber Friction Ring Facing

After the drum has been indexed to bring the location of a screw-hole under the drilling spindle, a bushing plate that may be seen at the rear of the fixture is swung over into position, and with the first spindle of the four-spindle machine, the tap drill is guided through the fiber strip and the ring. The second spindle of the machine is now indexed, and this brings into line a tool that countersinks the hole for the flat-head screw; the third spindle (which is the one shown in the illustration) carries the tap for tapping, and the fourth spindle carries a center into which the screwdriver in front of the fixture is inserted for guidance, and the 8-32 screw is driven in by hand.

How well the fixture works may be judged from the fact that the production, which by the old method was only three rings per day, has been increased to twelve rings per day by the use of this fixture. C. L. L.

* * *

SHELBY TUBING FOR TEXTILE MACHINERY

The great variety of sizes and shapes in which seamless steel tubing is made today has resulted in its use in lines of manufacture where seamed tubing has formerly been employed. One of these instances is its use as bodies of tube frames for carpet looms made by the American Warp Drawing Machine Co., Boston, Mass.

Fig. 1 shows one of these tube frames assembled, and in the foreground is the length of tubing used as a basis in making

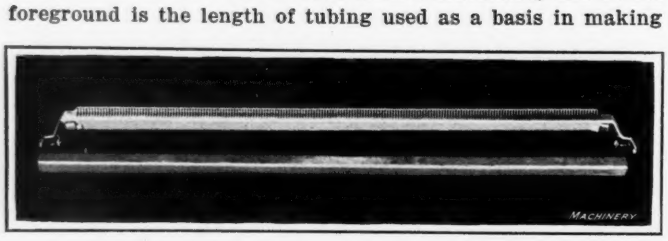


Fig. 1. Tube Frame for Carpet Loom and a Length of Tube

Fig. 2. How Tubes were seamed

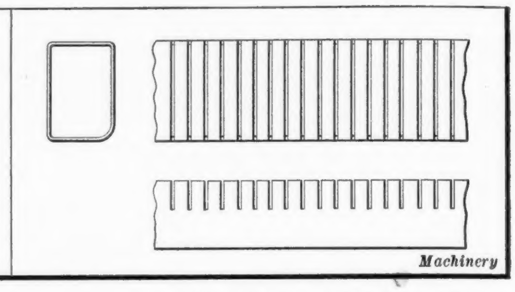


Fig. 3. Seamless Tubing, showing Slots for Inserted Guides

this frame. In every carpet loom there are from 200 to 700 of these tube frames, the number depending upon the style and size of carpet being manufactured. The tube is rectangular in form, with one edge rounded, and measures approximately three-fourths inch wide by one inch thick. The stock is steel, 20 gage. These lengths of tube vary from 16¾ inches to 27 inches, and in each there are a large number of slots in which the steel guides are inserted, as may be seen in the illustration. The tube frame shown is 27 inches long and is provided with 190 slots.

It was formerly the practice to use a tube bent from flat stock and electrically welded along the seam as shown in Fig. 2. This form of tube, however, was not satisfactory, as the seam would not hold in action. The slots, of course, weaken the tube, but the seam weakens it still more. Not only does a seamed tube lack the necessary strength, but it does not have the stiffness inherent in a drawn tube because of its method of manufacture.

Shelby seamless steel tubing was tried on this job with remarkable results, and Fig. 3 shows a section made in this way. In making the tube-drawing dies, one corner of the section was drawn with a larger radius than the others to conform to the design of the tube frame. Not only is the drawn tube much stiffer than the seamed tube, but under the real test of use in the loom there is no springing or twisting, and the life of the tube frame is increased several hundred per cent. C. L. L.

* * *

COST OF CONCRETE BUILDINGS

In an address before the Real Estate Exchange of Cincinnati, Ohio, W. P. Anderson, president of the Ferro Concrete Construction Co. of Cincinnati, gave some figures on the cost of reinforced concrete buildings. While it is true that many items included in the cost of such buildings will vary, Mr. Anderson took as a basis for his estimate a plain structure with no exterior decorations and included the principal items which make up the cost, such as walls, windows, floors, floor finish, stairs, toilets and plumbing fixtures. The costs of excavation, heating, lighting, and elevators vary so widely that they are omitted from the estimate.

The assumed load on the floors is 150 pounds per square foot with column spacing about 18 feet center to center and story height about 12 feet. Mr. Anderson estimated the base cost of a building 50 by 50 feet as about \$1.55 per square foot of floor area; if the building is 50 by 100 feet, the cost would be reduced to \$1.20; if 50 by 150, it would be \$1.12; and if 50 by 200, it would be \$1.07. In all these cases the building is assumed to be from four to ten stories high. A three-story building would cost somewhat more, but the difference would be slight. A two-story building would cost from 10 to 12 per cent more than these figures, and a one-story building from 12 to 20 per cent more. A decrease in the width of the building would increase the cost so that for a width of 25 feet instead of 50, the unit cost would be from 35 to 45 per cent

more and, on the other hand, if the widths are increased, the cost would be correspondingly decreased.

The effect of increasing or decreasing the floor load depends on the height of the building. Obviously, there would be practically no change in a one-story building, as the load comes directly on the ground. In a six-story building, the decrease in cost for a 75-pound load per square foot would be about twelve cents per square foot of floor space. This figure would also about equal the increase in cost if the live load were doubled. The effect on the cost of varying the column spacing is not great. When columns are spaced about 15 feet apart the cost is about six per cent greater than when spaced 25 feet apart both ways.

In giving these estimates of costs for reinforced concrete buildings, Mr. Anderson allowed two stairways and one elevator tower for a building under 150 feet in length, and two stairways and two elevator towers for greater length. Two plumbing fixtures per floor are allowed for the first 5000 square feet. No allowance was made for any interior partition work except that which is necessary around stairs, elevator shafts and toilets. The percentage of window area to wall area would have but little effect on the unit cost of the building. In calculating these estimates a steel sash window with ordinary glass was used; if wire glass were found necessary, the cost would be considerably more than for a plain wall.

* * *

WELDING HIGH-SPEED STEEL BLOCKS TO TOOL STEEL SHANKS*

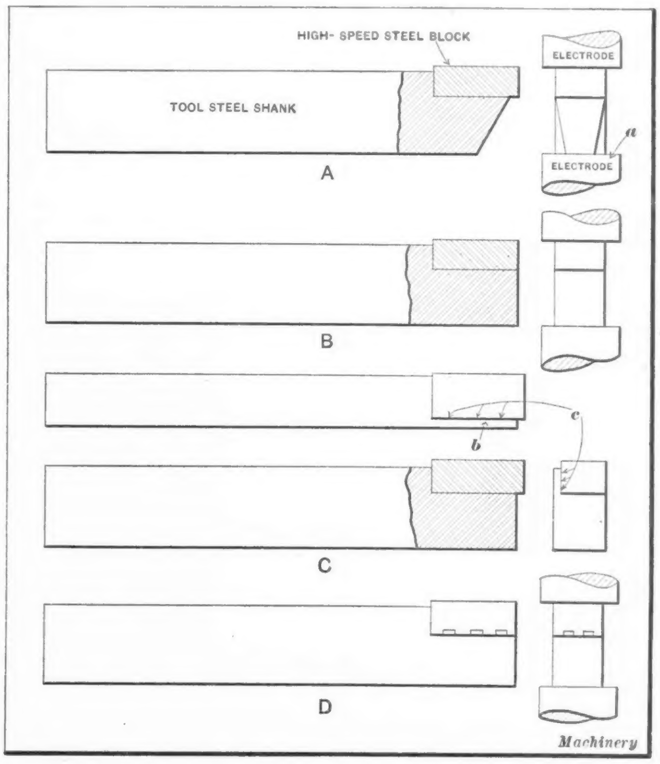
Owing to the high price of tungsten, high-speed steel has reached an almost prohibitive price, and many large manufacturers have either adopted the method of using high-speed steel bits in tool-holders or welding them to tool steel shanks. Manufacturers of electric welding machines have been called upon to supply machines for this purpose, and have been doing this work in their own shops to some extent. The work handed to them in many cases shows a lack of knowledge of the requirements which must be met if a satisfactory weld is to be made. It is essential, in resistance welding, to have the work clean and free from scale; and in making a butt-weld the cross-sectional area of the two pieces must be nearly equal.

An example which illustrates this point is shown at *A* in the accompanying illustration. One manufacturer sent a large batch of machine steel shanks in to have high-speed steel tips welded to them, and thinking that it was necessary to have the tool rough-formed to shape, he beveled it on the front end as shown, and provided a seat for the block. To weld a tool of this shape is practically impossible, because the smallest section is that lying next to the electrode *a*. It is practically impossible to get a welding heat between the two pieces, as the greatest point of resistance is between the electrode *a* and the smallest section of the piece. The correct way to prepare the blank is shown at *B*, where it will be seen that the cross-sectional area of the block and shank are equal.

Another condition which makes welding difficult is shown at *C*. Here the manufacturer thought he would increase the strength of the weld by leaving a rib *b* to back up the tool and resist the cutting action. With a holder or shank formed in this manner, it is a difficult matter to get the block and holder to weld at the points *c* as indicated. It also takes longer to make a weld because of the danger of burning the parts, due to unequal heating, caused by the difference in the cross-sectional area of the two pieces.

The easiest and quickest way to make a satisfactory weld is shown at *D*. Here the lower surface of the high-speed steel block is provided with a series of points or projections. These points localize the current and permit an equal temperature to be obtained. The current and time consumed in making the weld is also much less than when the block and holder are provided with plain surfaces.

Another point that has troubled many manufacturers contemplating the use of electric welding machines for this work is which type of welding machine is the most suitable; that is, a butt-welding or a spot-welding machine. Now, as far as the welding of high-speed steel bits is concerned, either a spot- or butt-welder can be used. The butt-welder, however, has the advantage over the spot-welder in that it is constructed so that a greater pressure between the electrodes can be obtained. Furthermore, it is more accessible. The machine to purchase for the work, however, depends to a great extent upon the product of the manufacturer. For instance, a manufacturer whose product consists chiefly of light work and sheet metal parts should purchase a spot-welder, whereas the manufacturer of fairly heavy machinery should purchase a butt-welding machine, because he can generally find other work for the welding machine to do, such as welding bolts, tie-rods, etc. The type of machine also depends upon the size of the tools to be welded. For welding large lathe tools, a butt-welder should



Correct and Incorrect Methods of welding High-speed Steel Blocks to Tool Steel Shanks

be used, while for welding small bits, 3/8-inch square, etc., a spot-welder can be employed to advantage.

One of the difficulties encountered in welding high-speed steel tips to tools is that of getting the correct relation between pressure, current and time. The current and time are more easily ascertained than the pressure required, and it takes considerable experience to know when the two materials should be brought together. Another point that many manufacturers overlook is that the physical properties of high-speed steel and tool steel are so different that severe strains are set up unless the pieces are heat-treated before they have a chance to cool down from the electric welding heat. The electric welding in this case, therefore, should be done near a furnace where heat-treatment can be accomplished, so that the greatest efficiency can be obtained from the tool. If it is not heat-treated directly after welding, the high-speed steel bit will develop severe surface cracks and its structure will be greatly weakened. It has been found by experiment that tool steel shanks, although more costly, give better results than those made from low-carbon steel. D. T. H.

* * *

In August, 1908, the Ford Motor Co. of Detroit, Mich., turned out its first model T type of touring car, and until January, 1916, had turned out exactly 1,000,000 model T touring cars. In the month of March alone, this company turned out 58,329 automobiles. Figuring on the total length of the Ford car as twelve feet, up to January, 1916, the company had turned out enough cars to reach from New York to Salt Lake City.

*For information on welding high-speed steel previously published in MACHINERY, see "Welding High-speed Steel Electrically," May, 1916, and other articles there referred to.

BALL BEARINGS FOR MOTOR-GENERATOR SETS

The motor-generator set of 282-ton electric locomotives now operating on the Chicago, Milwaukee & St. Paul Railway, which provides low-voltage current for the control and other auxiliaries, consists of a 3000-volt direct-current series motor, having a double winding and two commutators for operating in series at 3000 volts, a small generator for furnishing control current at 125 volts, a 120-volt generator furnishing current for regeneration and for charging storage batteries on passenger cars, and a blower of 13,000 cubic feet capacity for ventilating the main driving motors. It is also used in connection with regeneration on down grades, for lighting the locomotive interior, and for supplying the low-voltage incandescent headlight which takes current from collector rings at one end of the set.

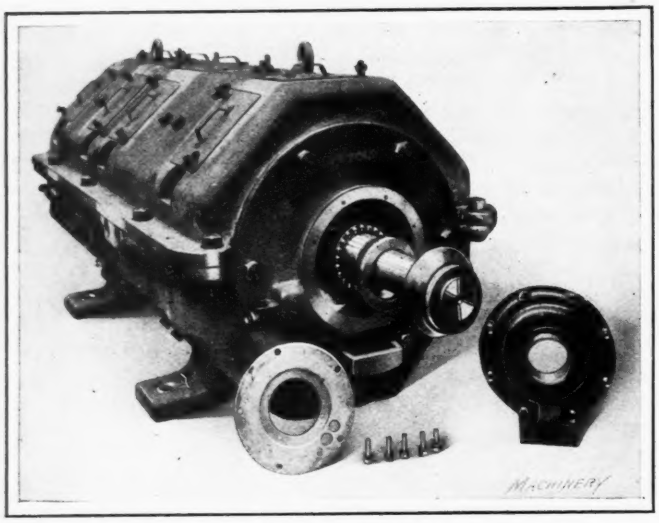


Fig. 1. Motor-generator Set with Bearing Cap removed to show Ball Bearings

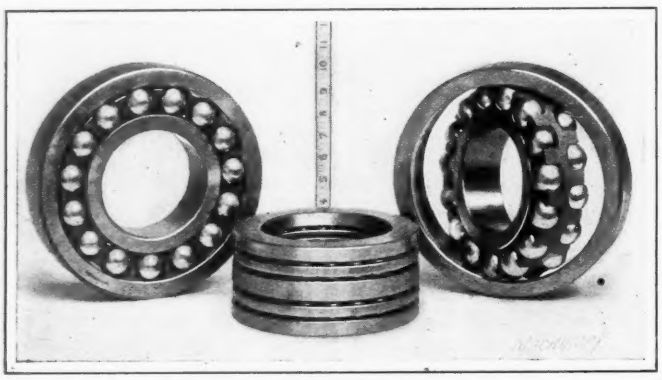


Fig. 2. Radial and Double-thrust Bearings

The shaft upon which the revolving element is carried is supported by two S. K. F. radial ball bearings, as shown in Fig. 1, and is protected from shocks due to end thrust by a double-thrust ball bearing, as shown in Fig. 3. The set is installed longitudinally in the locomotive cab and the thrust bearing takes up shocks incident to switching and train handling. This bearing has a capacity of over 5000 pounds at the normal speed of the set. The construction of the radial and thrust bearings is shown in Fig. 2; the outside diameter of the radial bearing is a little over 10 inches, the bore is 4.7 inches, and the weight, 33.5 pounds. The balls and races are made of Swedish crucible steel, and the ball retainers are of bronze.

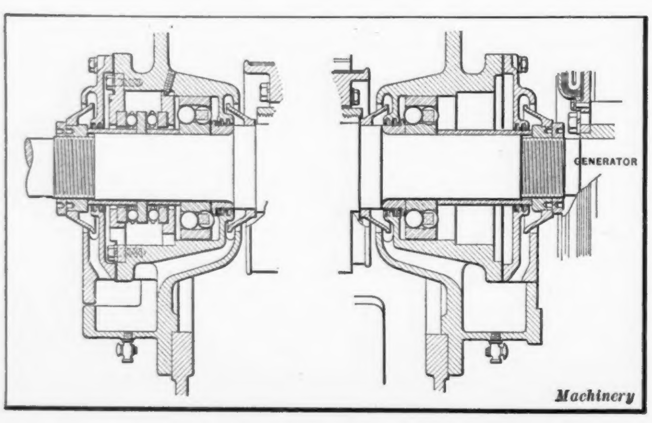


Fig. 3. Diagram showing Mounting of Motor-generator Sets

* * *

ENCOURAGING THRIFT

The Rockefeller Motor Co., Cleveland, Ohio, builder of engine lathes and spring-making machinery, encourages its employes to make weekly deposits in the savings bank by the use of the pay envelope shown in Fig. 1. The upper part is filled in with the date, the number of the employe, his name and the amount paid. This record is solely for the information of the employe himself and may be torn off on the perforated line. The lower part is good for one dollar on deposit when another dollar is deposited, and constitutes the bank's voucher as shown in Fig. 2. Thus the thrifty employe may accumulate deposits of two dollars weekly or $104 yearly by depositing only one dollar a week. Over 90 per cent of the employes have become depositors since the scheme was adopted, which speaks well for the plan.

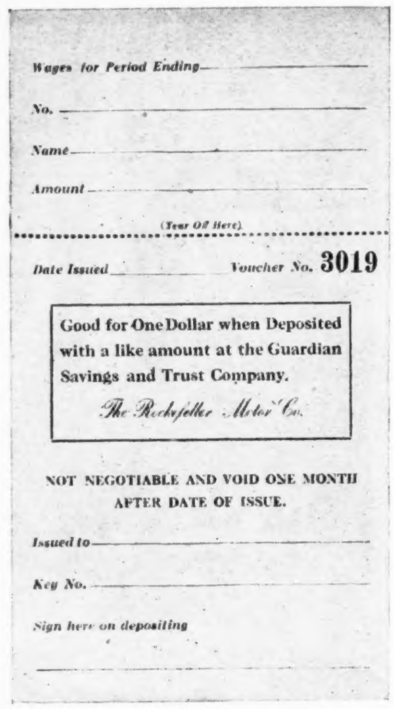

Wages for Period Ending
No.
Name
Amount
(Tear Off Here)
Date Issued Voucher No. 3019
Good for One Dollar when Deposited with a like amount at the Guardian Savings and Trust Company.
The Rockefeller Motor Co.
NOT NEGOTIABLE AND VOID ONE MONTH AFTER DATE OF ISSUE.
Issued to
Key No.
Sign here on depositing

Fig. 1. Pay Envelope used by the Rockefeller Motor Co. to promote the Saving Habit

* * *

MACHINE FOR PLANTING TREES

A machine that plants from ten to fifteen thousand forest tree seedlings a day is now being used at the Letchworth Park Forest and Arboretum in Wyoming County, New York. Previously the planting has been done by hand at the rate of twelve to fifteen hundred trees each day per man. The machine was designed to set out cabbage and tomato plants, but works equally well with trees. It is about the size of an ordinary mowing machine and is operated by three men and two horses. One man drives the team while the other two handle the seedlings. The machine makes a furrow in which the trees are set at any desired distance apart, and an automatic device indicates where they should be dropped. Two metal-tired wheels roll the dirt firmly down around the roots. Two attachments make it possible to place water and fertilizer at the roots of each seedling. Another attachment marks the line on which the next row of trees is to be planted. This is another example of our native ability to apply machinery to the accomplishment of hand tasks.

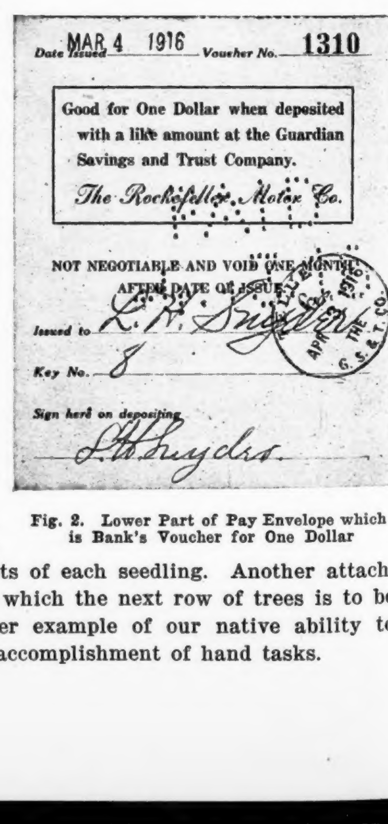

Date Issued MAR 4 1916 Voucher No. 1310
Good for One Dollar when deposited with a like amount at the Guardian Savings and Trust Company.
The Rockefeller Motor Co.
NOT NEGOTIABLE AND VOID ONE MONTH AFTER DATE OF ISSUE.
Issued to
Key No. 8
Sign here on depositing

Fig. 2. Lower Part of Pay Envelope which is Bank's Voucher for One Dollar

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

SHELL PRODUCTION OF U. S. MANUFACTURERS

The present capacity for making shells in the United States is approximately 300,000 per day with about seventy-five manufacturers engaged in this business. A number of concerns engaged in munition work are increasing their output, while others are taking on orders for different sizes of shells. Figuring on seventy-five manufacturers with a productive capacity of 4000 shells each per day, would give a production of 1,800,000 shells per week, and at present there are over that number doing this class of work, many of which have a production of over 4000 shells daily, so that the above estimate can be easily considered as conservative.

The most popular sizes of shells adopted by the foreign governments at war are 3-inch, 4.5-inch, 6-inch, and 9.2-inch. There are shells being made, however, in the following sizes: 1.0625-inch, 3-inch, 3.29-inch, 4.5-inch, 5.3-inch, 4.96-inch, 6-inch, 8-inch, 8.656-inch, 9.2-inch, 10-inch, and 12-inch. There are about five times as many 3-inch shells being made daily as any other size. Next in production comes the 4.5-inch, and then the 6-inch. Recently a large contract was let for 6-inch high-explosive shells.

At the present time there are between sixteen and seventeen concerns making forgings for high-explosive and shrapnel shells, with a combined production of over 300,000 shells a day, and at least six of these concerns have a capacity of over 20,000 forgings a day. For the smaller sizes of shells up to and including 6 inches, some manufacturers are using the bar stock method because of the high cost of forgings. Forgings range all the way from 8 to 12 cents a pound, and at this rate the bar stock method is cheaper; in fact, many manufacturers consider that a high-explosive shell can be made cheaper from bar stock than from forgings.

The cost and the time required for turning over from the production of shells for foreign governments to those for the United States government is a question about which there seems to be some doubt. It can be stated, however, that the only changes necessary would be in the tools and gages. As regards the exterior finishing of the shell, practically the only additional cost would be that necessary for gages, while for finishing the interior, new boring tools, reamers, taps, etc., would have to be made. These changes, however, could be made very quickly—in fact, within a month or so, so that the entire production of 300,000 shells per day could be turned over to the manufacture of U. S. munitions in this time if it were necessary.

Elizabeth, N. J. — A. B. HAZZARD

GRINDING MAGNETIC CHUCKS

The problem of grinding the magnetic chucks used on the various types of grinding machines, and especially those used on the Brown & Sharpe surface grinders which are found in most up-to-date tool departments, does not at first glance present many difficulties, but nevertheless there are few men who understand the method of producing a true and accurate surface on these chucks.

Some suggestions for obtaining a surface that will be true when tested with a knife straightedge are given in the following. The selection of the proper wheel is an important point, and the writer has found the Norton Co.'s crystolon wheels, grain 36, grade J, running at 5000 feet per minute (or 2800 revolutions per minute) for the 7-inch wheels generally used on these machines, to give the best results. With the proper wheel in place, the machine is started and allowed to run for a few minutes so that the oil on the ways and in the bearings will be spread evenly, before the cut is started. Previous to this time, the wheel has been trued up with a diamond dresser. It is now lowered to the surface of the chuck, and a cut not exceeding 0.0005 inch is used for roughing off the top of the chuck. No attempt should be made to take a heavier cut than this, and for the last few cuts, in finishing the surface, not more than 0.0001 inch should be removed.

It is best to feed the chucks under the wheel by hand rather than by power, as a cut at least one-half the width of the wheel face should be taken, both for roughing and finishing, and for this reason care should be taken to true the wheel properly before the final finishing cuts are made. The wheel should cut only on the forward stroke of the machine or when the work is traveling against the rotation, and precaution should be taken to brush off the top of the chuck before the return stroke. This point is important, because as the wheel passes over the chuck on its cutting stroke, particles of the cast-iron surface are removed, as well as a part of the soft metal cores used to separate the poles of the magnet. This cast-iron dust is either thrown out into the air or settles back on the face of the chuck, while most of the softer metal is forced into the pores of the wheel. If the cast-iron dust is allowed to remain on top of the chuck, the wheel, riding over the top of it on the return stroke, will force more or less of the dust into the soft metal which has already collected in the pores of the wheel, so that in a few strokes it will become so choked up and glazed over that on the lighter cuts it will ride over the surface of the chuck and not cut continuously. The result will be that the chuck will tend to have a "wavy" surface which can be readily detected by applying a straightedge to the surface.

There are two other important points in connection with grinding magnetic chucks which may be mentioned here. First, in truing up a wheel, the top of the chuck should be covered over with paper, so as to prevent the particles of abrasive from being driven into the face of the chuck. Second, for removing particles that have been driven into the chuck, an oilstone may be passed lightly over its face, thus leaving the surface clean and smooth.

Jersey City, N. J. — DONALD BAKER

TRUING OILSTONES WITH EMERY CLOTH

I have seen instructions published for truing oilstones, but in each case an important point has been omitted. It is often recommended to use emery cloth spread out on a plain surface, emery side up, and rub the stone on it until true. So far so good, but never rub the stone on the emery cloth dry. Use oil freely. When working with oil, the emery not only cuts many times faster than when working dry, but it leaves the surface of the oilstone in better shape to cut freely. The grade of emery cloth should vary with the character of the oilstone. The finer grades of cloth should be used for the fine stones, especially for finishing. The addition of grain emery of about the same grade as the cloth not only prolongs the life of the cloth but increases the rate of cutting. The loose emery is merely sprinkled on the cloth as the stone is being rubbed down. Those who have never tried this method of truing oilstones will be surprised at the rate of cutting obtained as well as the excellent cutting surface produced on the stone.

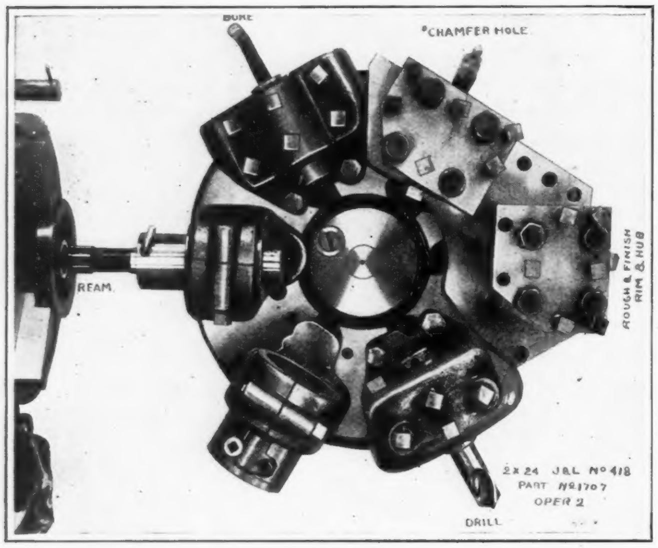
With a 1 by 2 by 6 inch carborundum stone, moderately coarse, I have cut away high-speed steel tools at one-fiftieth the rate an expert filer is supposed to use in cutting away soft steel when filing. I have reduced the length of a 5/8-inch square high-speed steel tool 0.016 inch in five minutes with

such a stone well supplied with turpentine. An expert filer is supposed to reduce a 1-inch square steel bar, 1 inch in length, in one hour.

Wilkinsburg, Pa. WILLIAM S. ROWELL

KEEPING RECORD OF MACHINE SET-UPS

In the plant of the Frost Gear & Forge Co., Jackson, Mich., a simple but satisfactory means is used for keeping an exact record of the tool set-up used on any particular job. Before the job is torn down, the camera is hung up on a skyscraper attachment and a photograph is taken of the tool set-up and work, as shown in the accompanying illustration. The operations are then indicated on the prints taken from this negative and the prints filed away. When the same job comes into the plant again, a print is handed over to the foreman,



Set-up of Tools for performing Second Operation on a Gear Blank

who gives it to the workman for setting up the machine. He can tell at a glance just where the various tools go and the types of tools used for the job, and within a short time has the tools all set up and the machine in operation. This method has been found to effect a great saving in time in setting up turret lathes in this plant. D. T. H.

MEASURING THREADED WORK

The following article describes two methods that I have found useful in measuring the diameter of threaded work. Fig. 1 shows a 1-inch micrometer with two 1/16-inch steel balls mounted in the spindle and anvil. In preparing the tool in this way I removed the anvil and spindle and lapped a cup shaped recess in each with the rounded end of a piece of hardened 1/16-inch drill rod held in the lathe tailstock while the work was rotated by the spindle. After getting approximately the required result in this way, each recess was finished by using a ball held in a split bushing mounted in the tailstock. The depth of the recesses is such that about three-quarters of the diameter of the ball is above the surface of the surrounding metal.

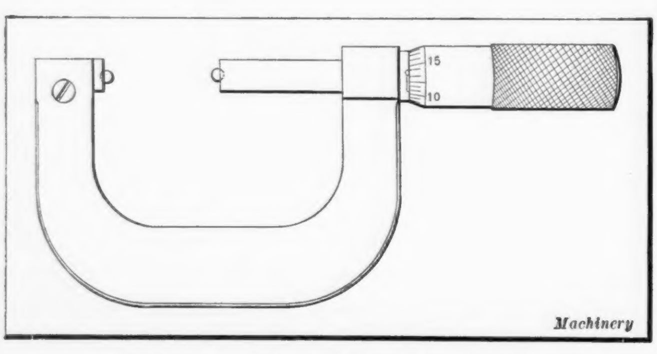


Fig. 1. Micrometer with Hardened Balls fitted in Anvil and Spindle to adapt Tool for measuring Diameter of Threaded Work

After the recesses had been formed, I magnetized the spindle and anvil by drawing them across the poles of a 5-inch horseshoe magnet. By so doing provision was made for holding the 1/16-inch balls in place in the recesses. At first thought one is likely to assume that when measuring a tap there would be a tendency for the balls to stick to the tap owing to their magnetism; but as each ball only bears against the tap at two points, while there is considerable surface in contact with the recess, the ball is held securely in place and does not give any trouble. A micrometer arranged in this way can be calibrated and used as a regular thread micrometer.

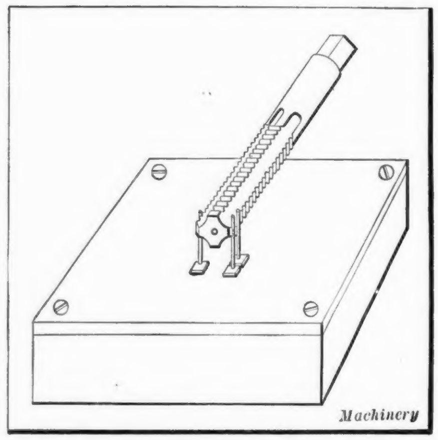


Fig. 2. Convenient Method of measuring Diameter of Threaded Work by Three-wire Method

Fig. 2 shows a convenient method of measuring threaded work by the three-wire system. For this purpose I made a block of wood 2½ by 2½ by 1 inch in size and screwed a piece of ground flat steel stock to it. I then made three steel blocks about ¼ by ¼ by ⅛ inch in size which I hardened, ground and lapped; and these blocks were subsequently magnetized by drawing them across the poles of a horseshoe magnet. Each block carries a piece of 1/16-inch drill rod, 1½ inch long, and by placing them on the plate as shown, the three wires can be moved to any position, where they will be held by the magnetized blocks. For measuring very small taps I made special blocks which had the wires mounted in the extreme corners to avoid trouble from interference. It will be evident that this device is used to measure the work by the well-known three-wire system.

Bridgeport, Conn. JAMES MCINTYRE

RUBBER JOGGING DEVICE FOR VISE JAWS

The milling operation illustrated in the accompanying halftone consists in cutting a slot 0.504 inch wide and approximately 1⅜ inch deep into a hole which has been previously drilled and reamed. The parts in which these slots are cut

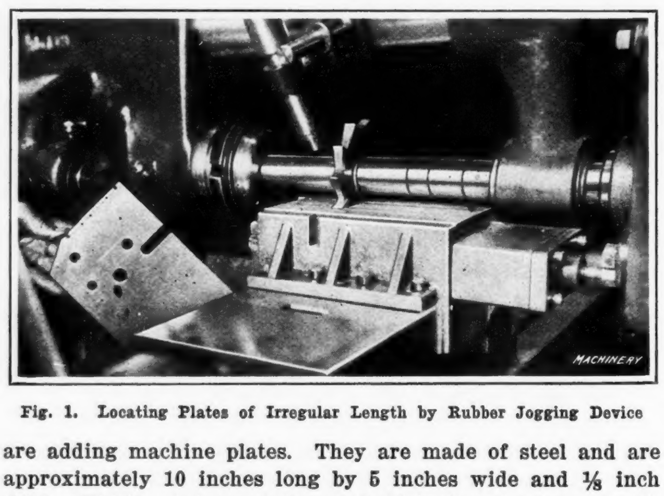


Fig. 1. Locating Plates of Irregular Length by Rubber Jogging Device

are adding machine plates. They are made of steel and are approximately 10 inches long by 5 inches wide and ⅛ inch thick. Thirty of these plates are held in the vise jaws at one time. It is essential that all the locating for this job be done from one end of the plate, as all previous operations have been located from this end. As the plates at this stage vary slightly in over-all length, some means had to be provided for jogging them up against the fixed stop *C*, Fig. 2. It was for this purpose that the W. H. Nichols Co., Waltham, Mass., designed the rubber jogging device *D*. This jogging

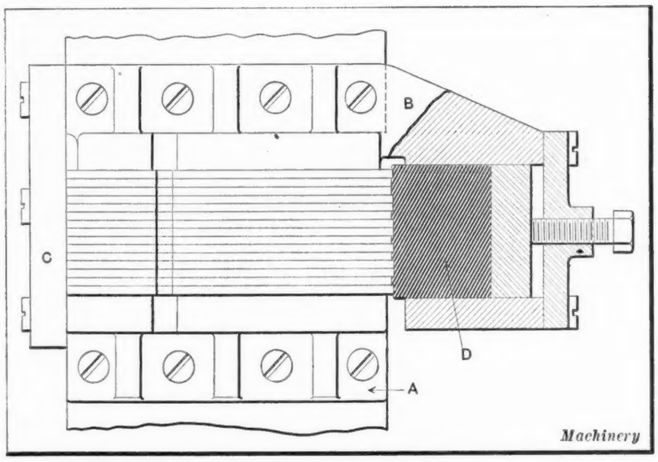


Fig. 2. Construction of Rubber Jogging Device

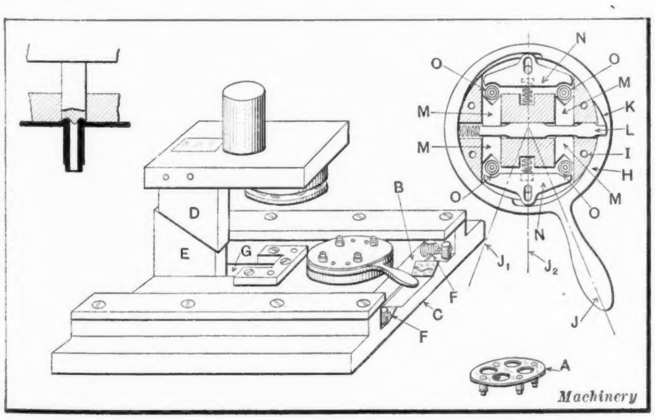
device consists of a piece of rubber approximately 4 inches wide, 3 inches long and 1½ inch thick. It slides in a slot cut in a projection from one of the vise jaws *B*, and is backed up by a small piece of steel of the same cross-section, against which the binding screw operates.

The operation of this device and its advantages are apparent. The rubber plunger when advanced by the screw is pressed against the ends of the plates and locates them accurately against stop *C*. After the parts have been milled and the vise jaws are removed to be placed in the tool crib, the rubber plunger should be well washed in gasoline to remove any oil that may cling to it. V. B.

RIVETING DIE

The accompanying illustration shows a riveting die developed for use in assembling the part shown at *A*. In designing this tool, particular attention has been paid to providing for the safety of the operator and to developing a form of mechanism which effectually prevents the work from sticking in the die after the riveting operation has been completed.

It will be seen that die-plate *B* is carried on a slide in base *C*, the motion of the die-plate on its slide being controlled by cams *D* and *E*. As the punch descends, die-plate *B* moves under it, carrying with it the work to be riveted. Then as the punch moves up, cam *E* is released, allowing springs *F* to draw the die-plate back to the starting position. By entering slot *G*, cam *D* locates the die in position under the punch ready for the performance of the riveting operation.



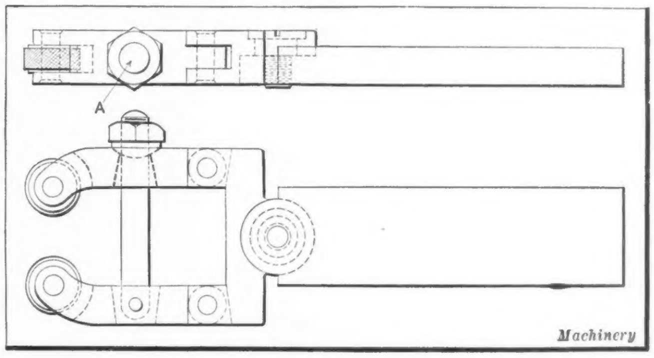
Riveting Die designed to provide for Safety of Operator and to make it Easy to remove Finished Work

At the right-hand side of the illustration is shown a detail view of the work-holding fixture. It will be seen that ring *H* is mounted on pad *I*, and by throwing handle *J* into the position J_2, cam *K* moves gage-pin *L* to bring jaws *M* into proper position. By moving handle *J* to the position indicated by line J_1, clamps *N* engage rivets *O* and hold them in place during the riveting operation. Then by moving the handle back to the position shown at *J*, the rivets are released to enable the work to be removed from the die. It will be evident from the illustration that the round plate and rivets are held in such a way that it is impossible for the work to stick in the die after the riveting operation has been completed.

Avenel, N. J. Adalbert O. Alexay

KNURLING TOOL

The knurling tool here described has been found to give very satisfactory results in knurling a great variety of products. One of the difficult operations performed with this tool consisted of knurling a piece of brass tubing ⅝ inch in diameter by 3 feet long, which was driven by a spring collet in a Hendey-Norton lathe. This work was produced without blemish. The efficiency of the tool is attributable to the rocker motion which allows it to follow the work regardless of any irregularity which may be encountered. The tool is set by first letting the knurls run lightly on the work, after which the cross-slide is locked; the required depth of knurling is



Knurling Tool with Rocker Joint that allows Knurls to follow Work

then obtained by tightening bolt *A* to force the knurls into the metal. It will be evident that any desired form of knurl may be employed on this tool.

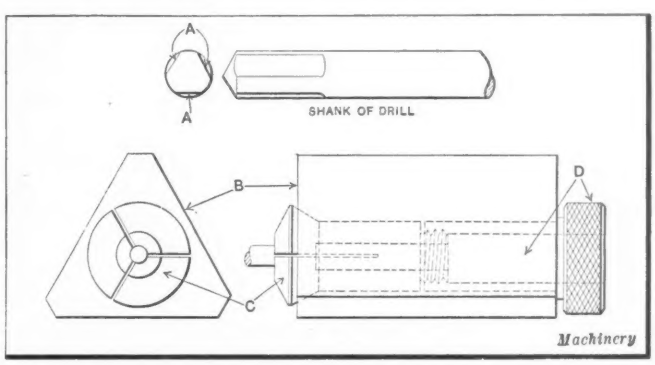
Knoxville, Tenn. J. Sidney Eicks

PREVENTING DRILLS FROM SLIPPING

We use a great many drills under 3/16 inch in diameter and have experienced trouble from the drills slipping in the small sized chucks that we use. In an effort to make the chucks hold more securely, operators have resorted to the use of monkey wrenches or other means of adding leverage to the usual chuck wrenches, with the result that they ruined the wrenches and often damaged the chucks. The chucks have three jaws, and to overcome difficulty from slipping we have adopted the practice of grinding three flats on the shank of the drill, as shown at *A*, just enough steel being removed so that the drill chuck jaws will hold securely on the flats.

The flats are easily ground on the shanks of the drills with the aid of a simple fixture that we designed for the purpose. It will be seen that this consists of a collet mounted in a triangular block. This block *B* is bored to receive collet *C*, which is operated by draw-spindle *D*. It is merely necessary to turn the fixture over on successive sides in order to locate the work for grinding the three flats on the shank.

Jersey City, N. J. Donald Baker



Shank of Drill and Fixture used for grinding Flats to prevent Drill from slipping in Chuck

INCREASING EFFICIENCY OF MACHINE TOOLS

It appears to the writer that it would be a good plan to mark feed-screws and elevating screws on machine tools in such a way that the operator would never be in doubt as to which way to turn a handwheel in order to secure movement in the required direction. It is often necessary to raise or lower a table, or to make some such change in the setting, and if the operator is not familiar with the particular machine he is running the question frequently arises, "Which way feeds in and which way feeds out?" It is true that most American machine tools are now equipped with right-hand screws, but there are still a sufficient number of exceptions to this rule to make some method of marking desirable.

The writer has seen a machine stopped during the performance of a delicate machining operation and the operator afraid to go on with his work until he had found a foreman who was able to tell him which way some screw had to be turned to feed in the desired direction without danger of spoiling the work. But foremen are not infallible, and many of them are not familiar with all the details of the machinery in their departments. Hence it would seem that marking feed-screws in such a way as to indicate the direction in which to turn all wheels and levers to move in or out would be of use to foremen as well as operators.

All guesswork would be done away with, so far as manipulation of feed-screws is concerned, by simply marking the collar on the screw with two arrows with the words "In" and "Out" beside them; the same idea could be carried through by employing arrows and other words such as "Right," "Left," "Up," and "Down." The use of such a method would relieve operators from all uncertainty regarding the way in which to use their machines, and would often be the means of preventing damage being done to the work.

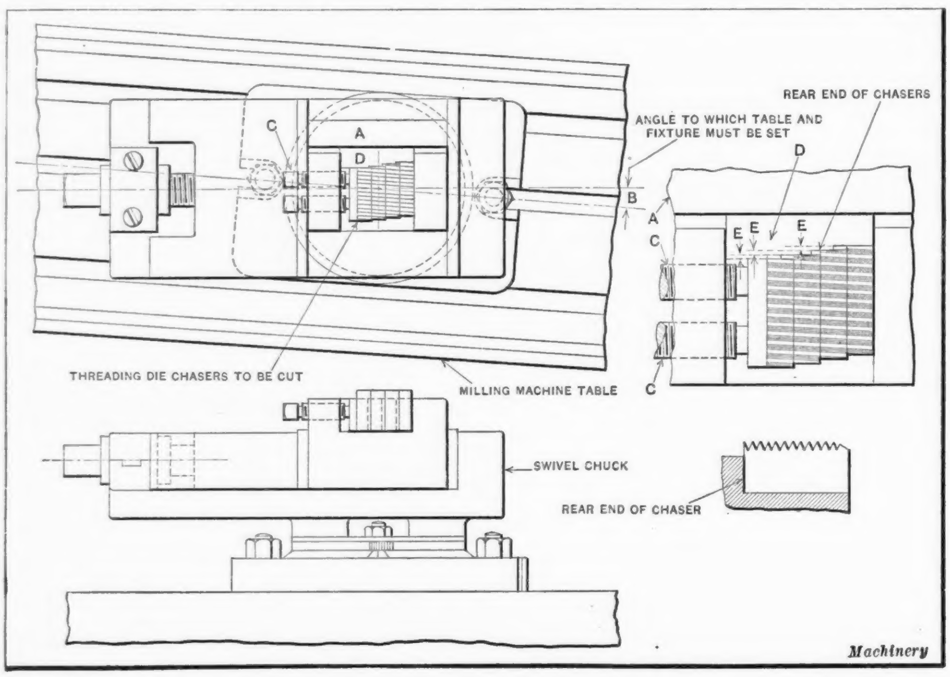
Plainfield, N. J. J. B. MURPHY

MILLING THREADING DIE CHASERS

The accompanying illustration shows a milling machine fixture used for machining threading die chasers. In many shops a special chuck is made to hold the chasers in place for threading, the chuck being used on an ordinary engine lathe. This method takes more time, and satisfactory results are not likely to be obtained unless a skilled toolmaker does the work. The use of a suitable fixture on the milling machine enables the work to be done more quickly and cheaply, provided the proper tools are employed.

Referring to the illustration, it will be seen that fixture *A* is mounted in a swivel chuck which may be set for any required thread angle. The angle is determined by dividing the lead of the thread for which the chasers are made by the circumference of a circle with a diameter equal to the required pitch diameter of the screw; this gives the tangent of the required thread angle, from which it is easy to determine the angle *B* at which to set the fixture. Two set-screws *C* are provided for use in tightening the chasers in place ready for milling. A step block *D* is laid in the fixture to obtain the required distance from the rear end of the chaser to the threads. Distance *E* on the step block is found by dividing the lead of the thread by the number of chasers in the die, assuming that the chasers are equally spaced. It is necessary to have different step blocks for each number of threads, although one block can be used for different threads if the number per inch is the same in all cases. A single milling cutter of the same shape as the required thread is used for cutting the chasers, and the cross-feed is employed for obtaining the required distance between the teeth.

Racine, Wis. A. J. DREMEL



Fixture for milling Chasers of Threading Dies

SCIENTIFIC CLOCK REPAIRING

Perhaps the writer of the article in the June number on "Scientific Clock Repairing" may be interested in the following tale from a well-known text-book on clocks—"The Modern Clock," by Ward L. Goodrich—in spite of its prolixity:

There must be in this country over 25,000 fine French clocks in expensive marble or onyx cases, which were given as wedding presents to their owners, and which have never run properly and in many instances cannot be made to run by the watchmakers to whom they were taken when they stopped. Let me give the history of one of them. It was an eight-day French marble clock which cost $25 (wholesale) in St. Louis and was given as a wedding present. Three months later it stopped and was taken to a watchmaker well known to be skillful and who had a fine run of expensive watches constantly coming to him to be repaired. He cleaned the clock, took it home and it ran three hours. It came back to him three times; during these periods he went over the movement repeatedly; every wheel was tested in a depthing tool and found to be round; all the teeth were examined separately under a glass and found to be perfect; the pinions were subjected to the same careful scrutiny; the depthings were tried with each wheel and pinion separately; the pivots were tested and found to be right; the movement was put in its case and examined there; it would run all right on the watchmaker's bench, but not in the home of its owner. It would stop every time it was moved in dusting the mantel. The owner became disgusted and took the clock to another watchmaker, a railroad time inspector, with the same result.

In this way the clock moved about for three years; whenever the owner heard of a man who was accounted more than ordinarily skillful he took him the clock and watched him "fall down" on it. Finally it came into the hands of an ex-president of the American Horological Society. He made it run three weeks. When the owner found the clock had stopped again he refused to pay for it. Three months later the watchmaker called and got the clock, kept it for three weeks, brought it back, and lo! the clock ran. It would even run considerably out of beat. When asked what he had done to the clock, he merely laughed and said "wait." A year later the clock was still going satisfactorily and he explained: "That was the first time I ever got anything I couldn't fix, and it made me ashamed. I kept thinking it over. Finally one night in bed I got to considering why a clock wouldn't run when there was nothing the matter with it. The only reason I could see was lack of power. Next morning I got the clock and put in new

mainsprings, the best I could find. The clock was cured. None of these other men who had the clock took out the springs. They came to me all gummed up, while the rest of the clock was clean, bright, and in perfect order. I cleaned the springs and returned the clock; it ran three weeks. When I took it back I put in stronger springs because I found them a little soft on testing them."

Many good watchmakers know little, I fear, about clocks, having an idea that there is but little to know. I could tell several tales more or less like that in the June number:

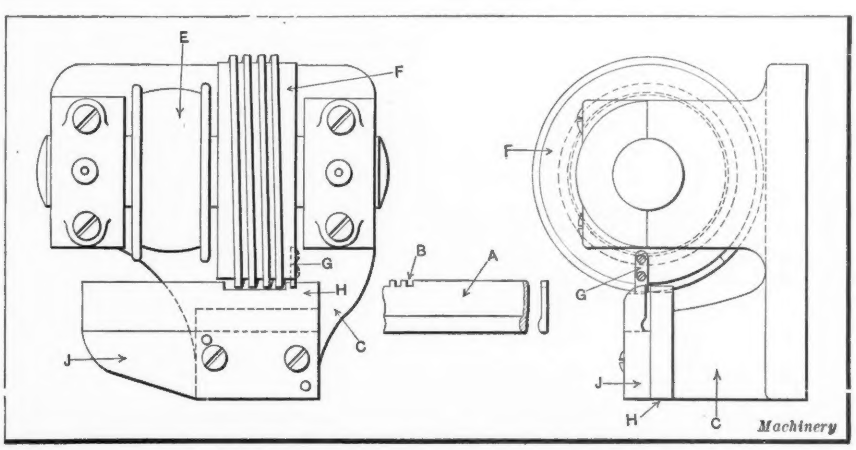
One watchmaker cleaned his "regulator" carefully, with his own skillful hands, but the kind of time it kept afterward was scandalous. Three times he took it apart, looked it over minutely, and set it up, but all in vain. As it had been a truly upright and virtuous piece of mechanism for several years, he couldn't well ship it back to the makers with a letter saying it was "N. G.," as is customary in the case of newly purchased clocks that fail to function satisfactorily. He mournfully told the sad tale to a friend who was supposed to know something of clocks. This man took off dial, hands and hour wheel, replaced them, and the mysterious trouble was ended. The maker had put counterbalances for the hands, one on the center staff, the other in the hour wheel, which Mr. Watchmaker had apparently failed to observe. At any rate, he had replaced the hands out of proper relation to their counterweights.

New London, N. H. GUY H. GARDNER

NOTCHING MACHINE

It is my purpose to describe a machine designed for cutting notches in metal molding. This machine is used in place of a punch press, and the somewhat unusual lines upon which it is designed enables the work to be done very rapidly. The metal of which the molding is made is quite soft, having a composition somewhat similar to pewter metal. Referring to the illustration, it will be seen that a portion of the molding is shown at *A*, part of the notched section being shown at *B*.

The machine consists of a cast-iron base or frame *C* on which is mounted a driving pulley *E* and drum *F*. The drum has a square thread cut on it, the lead of which corresponds to the notches which it is required to cut in the molding. The first turn of the thread is cut away from the drum and an inserted cutter *G* mounted in its place and secured by two screws. This cutter acts in conjunction with die *H* mounted at the front of the machine and cuts one slot in the molding for each revolution of the drum. A stock guide is provided at *J* to assist in feeding the material into the machine.

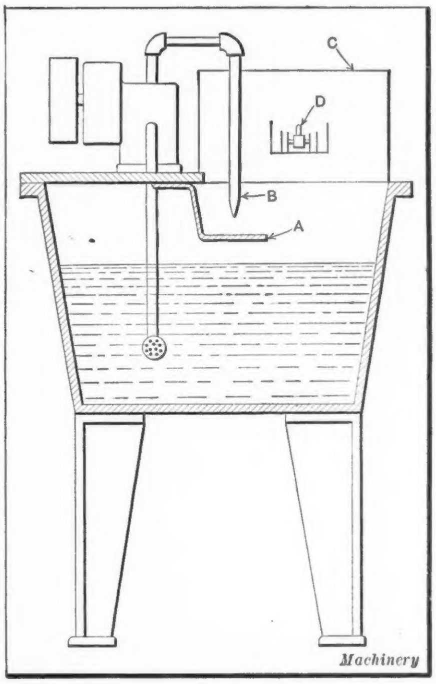


Machine designed for cutting Notches in Work shown at A

The stock is purchased in strips and is fed through the slot in guide *J* until it comes into contact with the thread on drum *F*. As the drum revolves, cutter *G* punches the first notch in the stock, and on the next revolution this notch is caught by the thread; then from this point the thread acts as an automatic feed and carries the stock forward at the required rate to secure a uniform pitch for the notches. This feed mechanism enables the machine to be run at high speed when it is working on soft metal.

D. B.

SPRAYING OUTFIT



Tank and Pump for Use in spraying Anti-rust Solution onto Iron Castings

We had a large number of iron castings which had to be machined all over and then dipped in an anti-rust solution to prevent rusting in service or damage while being shipped. The dipping was slow and a large amount of space was required to allow the castings to drain after they had been dipped; this method also resulted in wasting a lot of the anti-rust solution.

In looking for a more efficient method, we hit upon the plan described in the following. The equipment used consisted of a tank to hold the anti-rust solution which was made of a mixture of equal parts of kerosene and screw cutting oil. As shown, the tank cover plate extends over half the top and serves as a support for the pump. The discharge from the pump falls on plate *A* which is located directly beneath delivery pipe *B*, so that the solution rises from the plate in a mist-like spray. A tin cover *C* was provided to prevent the solution from being thrown onto the floor and wasted.

Inside the cover are six rails *D* made of 1/8-inch flat steel, and at the center there is a special chain belt with hooks placed at intervals to provide for pulling the castings through. Rails *D* extend a foot beyond the cover at each end to afford plenty of room for loading and unloading, and the openings in the cover are just large enough to allow the castings to pass through. The outer rails are made somewhat higher than those at the middle in order to keep the work traveling in the desired path. While the castings are passing through the hood they receive a light coating of the anti-rust solution which is adequate to protect them from damage.

Middletown, N. Y. D. A. HAMPSON

ROD NOTCHING DIE

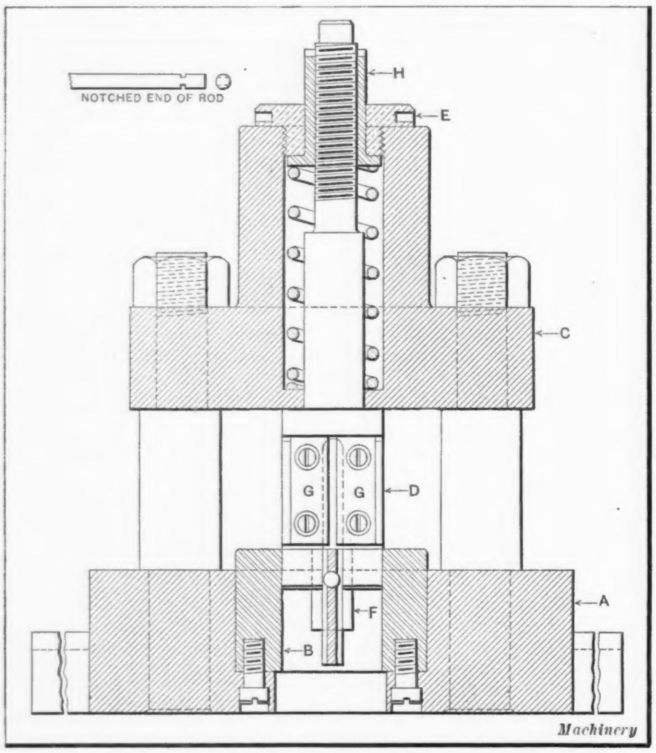
In the following is described a die which has given very satisfactory results for notching small rods. It will be seen that this tool is built on the sub-press principle; and 25,000 rods were notched with it at the rate of 1000 per hour, with the power press operated by an inexperienced workman. After finishing this run, the cutter showed no perceptible wear and there was no more tendency for the stock to tear during the latter part of the run than at the time the job was started.

Referring to the illustration, it will be seen that the tool consists of a cast-iron die shoe *A* which is planed at the top and bottom and bored to receive die retainer *B*. In addition, four holes are drilled to receive upright posts which are driven into place and riveted flush at the bottom. Punch-holder *C* is made of cast iron and bored to receive cutting plunger *D* and the pull-back spring; it is also threaded at the top of the bore to receive screw bearing *E*.

Die retainer *B* is made of mild steel and slotted to receive cutting die *F*,

the construction of which will be readily understood from the illustration. The die is held in the retainer by screws, after which the retainer is driven into the piece and also secured in place by set-screws. Owing to its shape, which makes the die quite delicate, it is made of high-gradé tool steel carefully tempered and ground, and held in a way which affords ample support. The widths of the grooves correspond to those which are to be cut in the rods. A hole of slightly larger diameter than the rod is drilled in the die and extends through the cutting section of the die. A set-screw and lock-nut form an adjustable gage which engages the end of the work and locates the notches at the desired distance from the end of the rod.

Plunger *D* carries notching punches *G;* the plunger is made of mild steel and is cut away to provide seats for the different parts. The cutters are held in place by cap-screws which are so placed that when the cutting points are worn and ground up as far as possible, they can be turned end for end to provide for using the opposite points. The upward thrust of the cutters is received by the shoulders and the outward thrust by the raised portions of plunger *D*. The plunger is turned down



Sub-press Die used for cutting Notches in End of Rod

to fit bearing *H* and the shoulder acts as a stop to limit the upward stroke of the plunger. The compression spring lifts the plunger from the finished work when the operation is completed. The tensioning of this spring is regulated by bushing *H*. Threaded cap *E* serves the additional purpose of supporting the plunger bearing.

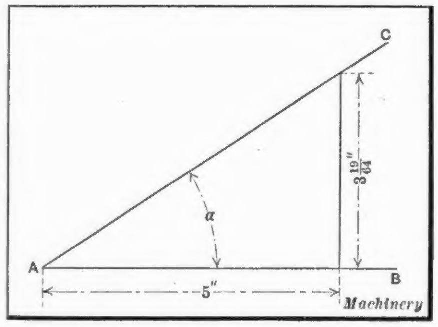
Chicago, Ill. H. FIELD MCKNIGHT

MEASURING ANGLES

In the May number of MACHINERY J. J. gives a method of measuring an angle without using a protractor, but it appears to the writer, who has occasion to measure and lay out angles daily, that there is a shorter and better method. In the illustration, let it be assumed that we wish to ascertain how many degrees and minutes the angle *BAC* or α contains. First mark off a convenient distance on the base line in some even number of inches; the longer the distance the better. In this case 5 inches was used. From this point erect a perpendicular. Next measure this line with an accurate scale. In this case it is 3 19/64 inches or 3.2968 expressed in decimals. Divide this by 5, as we are using trigonometry which necessitates working on a basis of 1. 3.2968 divided by 5 gives us 0.65936, which in a table of tangents we find to be the tangent of 33 degrees, 24 minutes, nearly.

This method is used by many draftsmen who have occasion to measure angles without the use of a protractor, and the accuracy of the results can be safely relied upon.

F. B. JACOBS
Indianapolis, Ind.



Measuring Angle by its Tangent

JAPANNING OVEN

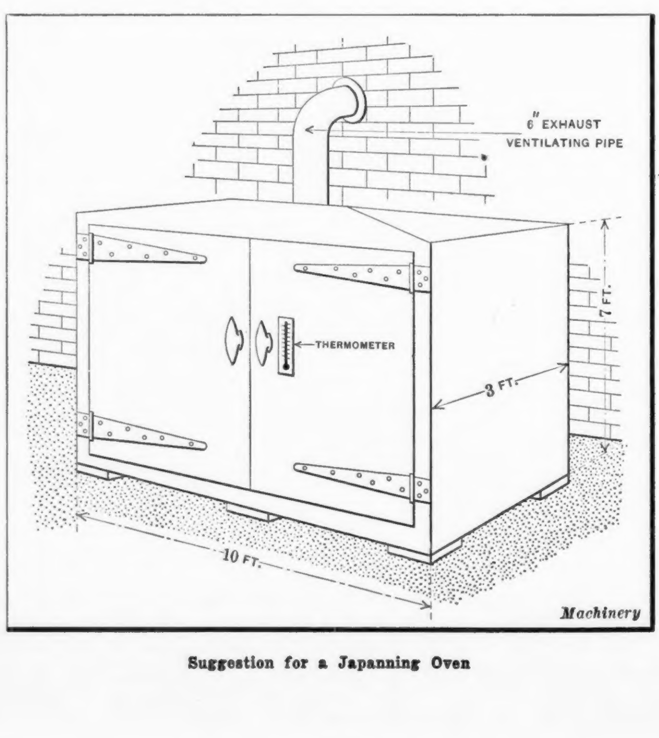
In reply to several inquiries which have been made in regard to japanning ovens, the following information is given by the writer for the benefit of those who wish to make and design their own ovens. The ovens are made on a framework of angle iron, on the outside and inside of which light sheet iron is fastened, the space between the sheets being filled with three-inch magnesia packing. For electrically heated ovens, it is best not to have any ventilation at the bottom, although theoretically this may seem to be better practice; nevertheless, experience has demonstrated the fact that ventilation may be dispensed with and satisfactory results secured.

At the top of the oven proper, an exhaust ventilating pipe, as indicated in the accompanying illustration, should be installed, and under ordinary conditions the natural draft will remove all the fumes caused by baking. The front of this oven has two large swinging doors opening to the full size of the oven, so that the work which is to be baked can be placed properly. The electric coils should be placed about three inches from the bottom of the oven and fairly well distributed over this area. On top of the coils a perforated sheet of metal should be placed to catch all work that might accidentally drop from the suspended bars above. When very heavy work is to be baked, such as cylinders, etc., provision should be made for properly supporting this plate, so that it will sustain the extra weight. Light work can be baked to better advantage by suspending it from supports suitably arranged in the oven.

Kenmore, N. Y. GEORGE B. MORRIS

* * *

If there is any one principle more than another which is influential in promoting the success of an organization, it is the following: The authority to issue an order involves the responsibility to see that it is properly executed.—*H. L. Gantt, in Industrial Leadership.*



Suggestion for a Japanning Oven

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

USE OF LEVELS IN SETTING UP WORK

H. G. E. Co.—The men in our shop use levels to set up work on the machines instead of a square or surface gage, but not one of the machines in the shop is level. Is the practice permissible?

A.—The practice certainly is not permissible if accurate work is required. Levels should never be used for setting up work on floor-plates, platens and machine tables unless the latter themselves are level. Whenever there is doubt about the machine table surface being level, a surface gage or other means of working from the table itself should be used instead of a level.

CHAMFERING THREADING DIES

W. M.—"A" claims that in backing off a threading die it is the common practice of die manufacturers to file one land ahead of the others, while "B" claims that it is not the practice and that the die should be chamfered and then filed or milled to form a cutting edge so that the teeth in each land cut equally. Which is right?

A.—The general practice of the manufacturers of dies is to chamfer each land as claimed by "B." Theoretically, it would be desirable to divide up the cut on the leading teeth in each land as suggested by "A," but if this were done, it should be done so that each of the four leading teeth in the four lands would do its proportionate part of the cutting. This would be a condition very hard to realize even in a new die chamfered by special means, and it would be quite out of the question to maintain that condition in common use.

LAYING OUT A THREAD CHASING INDICATOR

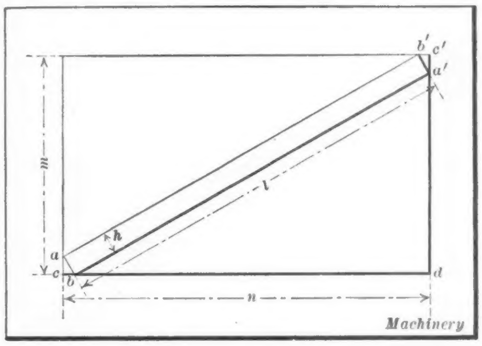
F. J. S.—In reading Machinery, I have noticed with much appreciation your How and Why department, and the interesting problems answered. Will you kindly answer the following question: How should one proceed to design the chasing dials for screw-cutting lathes geared even, two to one and one and one-half to one? The lead-screw has a lead of ¼ inch or four threads to the inch. Please give number of teeth in worm-wheel, also number of graduations on dial.

A.—A thread chasing indicator on the carriage of a screw-cutting lathe is for the purpose of showing the position of the split nuts in relation to the lead-screw. The gearing of the lathe and the pitch of the lead-screw do not enter into the problem. The number of teeth in the worm-wheel is also immaterial except as it affects convenient marking of the dial. Thirty-two teeth are often used for the worm-wheel, as this number facilitates the use of the indicator when cutting multiple threads. Any number divisible by 4 is convenient for marking, but any other number may be used with equal facility when cutting single pitch threads. The use of the indicator is simply for the purpose of showing the operator when the split nut can be closed on the lead-screw without changing the position of the carriage.

CUTTING SPIRALS WITH SCROLL CHUCKS AND JAWS

T. M.—I had to cut a spiral groove 3½ threads per inch, 12 inches diameter, in a scroll ring and groove three jaws to fit for a self-centering or universal chuck. I cut the scroll ring first, then made a jig ring with three divisions planed radially for the jaws to fit in, and fastened the jaws in place with set-screws. The ring and jaws were chucked and the jaws were faced and bored, and then the spiral groove was cut across the face. A clearance of about 0.010 inch was provided. But I could not get the scroll ring to mesh with the jaws, although they were both cut on the same lathe. By slacking off the set-screws and moving one jaw inward half the pitch, the spiral ring would mesh all right. We had to rebore the jaws in order to have them center the work. I would be obliged if you would explain the cause of my trouble.

A.—Your trouble was probably due to the fact that you cut both spirals in the same direction, when you should have cut the spiral in the scroll ring clockwise and the spiral in the jaws counter-clockwise, or *vice versa*. By this, we mean that if you cut the spiral in the scroll ring with the lathe running as usual and the tool feeding from the outside to the center, the spiral in the jaws should be cut with the tool feeding from the center out, the lathe running in the usual direction. Thus, your spirals will mesh and you will have no trouble.



Laying out Diagonal Strip in Rectangle

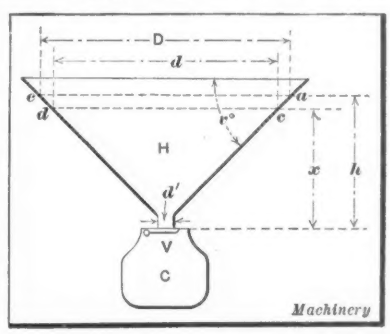
LAYING OUT DIAGONAL STRIP IN RECTANGLE

H. T. D.—What is the length of the longest strip 3 inches wide having square corners that can be laid out in a rectangle 24 by 40 inches?

A.—Referring to the diagram, triangles *acb* and *a'c'b'* are equal; they are also similar to the triangle *bda'*. Let $ac = x$ and $bc = y$; then $\frac{x}{y} = \frac{m-y}{n-x}$; from which, $nx - x^2 = my - y^2$. Also, $x^2 + y^2 = h^2$; from which, $y = \sqrt{h^2 - x^2}$. Substituting this value of y in the preceding equation and transposing, $2x^2 - nx - h^2 = -m\sqrt{h^2 - x^2}$. Squaring both sides, transposing and collecting terms, $4x^4 - 4nx^3 + (n^2 + m^2 - 4h^2)x^2 + 2nh^2x + h^2(h^2 - m^2) = 0$. Here, $n = 40$, $m = 24$, and $h = 3$. Substituting these values and reducing, $4x^4 - 160x^3 + 2140x^2 + 720x - 5103 = 0$. Solving this equation by Horner's method, $x = 1.451955 +$, say 1.4520; $y = \sqrt{3^2 - 1.452^2} = 2.6252$. From the similar triangles *acb* and *bda'*, $\frac{l}{n-x} = \frac{h}{y}$; from which, $l = \frac{(n-x)h}{y} = \frac{(40-1.452)3}{2.6252} = 44.052$ inches. J. J.

FLOW THROUGH VALVE OPENING

M. O. F.—In the illustration, *H* represents a hopper designed to hold water. Assuming that the valve *V* is suddenly opened, kept open for one second, and then suddenly closed, what should be the diameter *d'* of the opening to discharge 0.233 cubic foot into the vessel *C* when the height or head of water *h* is two feet over the valve seat?



Illustrating Size of Valve Opening for discharging 0.233 Cubic Foot of Water per Second

A.—It is impossible to answer the question as stated. If we assume the hopper to be a cone, and, for simplicity, assume further that the angle *v* is 45 degrees, we may proceed as follows: Let *ae* be the water level before the valve is opened, and let *cd* be the water level after the hopper has discharged 0.233 cubic foot. The volume *eacd* is a frustum of a cone, and its cubical contents = 0.233 cubic foot. But, from mensuration,

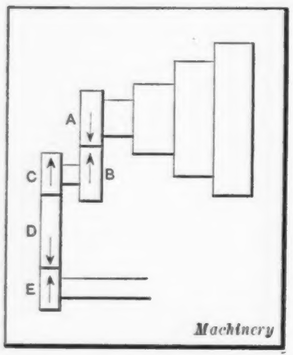
volume of frustum of cone $= \frac{\pi}{12}(D^2 + Dd + d^2)\,s$, where $s =$ perpendicular distance between the bases $= h - x$ in the diagram. Now, since $v = 45$ degrees, $D = ae = 2h = 2 \times 2 = 4$ feet, and $d = cd = D - 2s$. Substituting these values, $\frac{\pi}{12}[4^2 + 4\,(4 - 2s) + (4 - 2s)^2]\,s = 0.233$. Substituting 3.1416 for π, combining, reducing, and arranging terms, we obtain the cubic equation $1.0472\,s^3 - 6.2832\,s^2 + 12.5664\,s - 0.233 = 0$, from which, by Horner's method, $s = 0.0187$ foot. Hence, $x = h - s = 2 - 0.0187 = 1.9813$ foot. It has here been assumed that the apex of the cone comes to the level of the valve seat. Now, assuming that the corners are nicely rounded,

$$d' = \sqrt{\frac{D^2}{5h^2t}\,(h^{\frac{5}{2}} - x^{\frac{5}{2}})} = \sqrt{\frac{4^2}{5 \times 2^2 \times 1}\,(2^{\frac{5}{2}} - 1.9813^{\frac{5}{2}})} = 0.3208$$

foot $= 3.85$ inches. In this formula, $t =$ the time in seconds $= 1$ in this case. It has been assumed that no water is flowing into the hopper while it is discharging. J. J.

CHANGE-GEARS FOR THREAD CUTTING

J. P.—On page 874 of MACHINERY'S HANDBOOK, a rule is given for calculating the change-gears for cutting screw threads; will you please explain how this rule is derived?



Change-gears for Thread Cutting

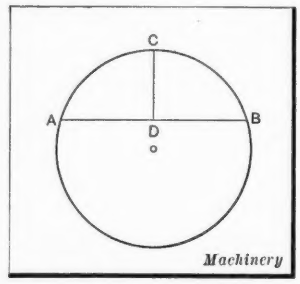
A.—The usual arrangement of the gears is shown in the illustration. Gear C is the change-gear on the stud and gear E is the change-gear on the lead-screw; gear A is on the spindle, B is on the stud, and D is an idler, whose function is to change the direction of rotation of the lead-screw. The arrows indicate the direction in which the gears rotate. Now if A and B have the same number of teeth, and if C and E also have an equal number of teeth, one revolution of the spindle will revolve A, B, C and E once, and the carriage will advance an amount equal to the pitch of the lead-screw. If B is n times as large as A (n is usually 2, 2½, or 3), one turn of A will produce only $\frac{1}{n}$ turn of B, and if C and E are equal, the carriage will advance only $\frac{1}{n}$ of the pitch of the lead-screw. This is equivalent to a lead-screw having n times as many threads per inch; hence the term lathe (or lead) screw constant, and this constant can evidently be determined by noting the number of threads per inch that will be cut when gears C and E are equal. Suppose that the lead-screw has six threads per inch and that $n = 2$; then the constant is $6 \times 2 = 12$, and when the spindle makes one turn, the carriage advances 1/12 inch. Now suppose that it were desired to cut a screw having seven threads per inch; evidently gear C must be larger than gear E, since the carriage must move a greater distance than when C and E are equal. The pitch of the thread to be cut is 1/7 inch, and we have the proportion $C : E = \frac{1}{7} : \frac{1}{12}$, or $\frac{C}{E} = \frac{12}{7}$. Multiplying both terms of this fraction by 4 (this does not change its value, of course), the result is $\frac{48}{28}$. Therefore, gear C should have 48 teeth and gear E 28 teeth, the same values as would be obtained by the rule. The rule is simpler, however, since it does not make use of fractions.

J. J.

CYLINDRICAL TANK CALCULATION

R. L. C.—A cylindrical tank 60 feet high and 12 feet in diameter should be provided with an overflow opening at such a height in the head that the contents will overflow when the tank is two-thirds full. How can the location of this hole be found?

A.—Referring to the accompanying illustration, the problem may be stated mathematically as follows: Find a line AB so located that it divides a circle 12 feet in diameter into two parts, the area of one part being equal to two-thirds of the area of the circle, and the area of the other part being equal to one-third. This problem cannot be solved by any direct mathematical formula. It is easily solved, however, by the use of a table of "Segments of Circles," such as is given on pages 62 and 63 of MACHINERY'S HANDBOOK. Tables of this kind are, in fact, prepared for the very purpose of solving problems like this, for which no simple mathematical formula can be provided. In the present case the problem resolves itself into finding the height CD of the segment of a circle the area of which is one-third of the total area of the circle. The table referred to is based on a radius equal to 1. The area of a circle with a radius equal to 1 is 3.1416. One-third of this area equals 1.0472. By inspecting the table on page 63 of MACHINERY'S HANDBOOK, in the column "Area of Segment," it will be found that a segment having a center angle of 149 degrees and a height of 0.7328, very nearly meets the requirements. As the radius in the problem is 6 feet, the height CD in the problem would equal 6×0.7328, or 4.4 feet, very nearly.



Cylindrical Tank Calculation

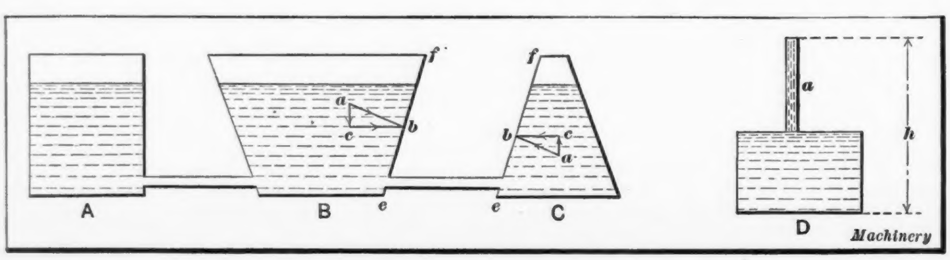
The uses of the mathematical tables given in MACHINERY'S HANDBOOK for solving many problems of this and similar kind are perhaps not as well appreciated as they should be. To a man who must do a great deal of calculating, the tables of "Powers, Roots and Reciprocals," "Circumferences and Areas of Circles," "Segments of Circles," "Lengths of Chords," etc., will save a great deal of time and facilitate the solution of problems and equations by trial and inspection to a great extent.

PASCAL'S LAW

H. M. S.—What is Pascal's law, and who was Pascal?

A.—Blaise Pascal was a great French mathematician and scientist (1623-1662). There are several theorems and principles, or laws, bearing his name, but we assume that the one to which you refer is that relating to hydrostatic pressure. In stating the law, it is assumed that the word "pressure" means specific pressure, *i. e.*, pressure per unit of area, as pounds per square inch, kilograms per square centimeter, etc. Then, if a vessel be entirely filled with a liquid, and a pressure be exerted anywhere on the mass of the liquid, it follows, according to Pascal's law, that the pressure is transmitted undiminished in all directions and acts with the same force upon all surfaces in a direction perpendicular to each element of those surfaces. This is the most important law in hydrostatics, but only a few of the conclusions derived from it can be considered here.

Referring to the illustration, A, B, and C are three vessels partly filled with water and connected by pipes, as shown; then the water stands at the same level in each vessel. To prove this, note that the pressure of the water at any point is equal to the weight of a column of water



Illustrating Pascal's Hydrostatic Law

whose area is the unit of area (say, 1 square inch) and whose height is the depth of the point below the upper surface of the water. If, therefore, the water were a little higher in one vessel than in the others, the pressure at any particular point would be a little greater than at the same level in the other vessels, and this extra pressure would cause the water to flow from that vessel to the others until the pressure was equalized. Again, if the areas of the bottoms of the three vessels are the same, regardless of their shapes, the total downward pressure on their bottoms will also be the same. In vessel *B*, the pressure acting on an element of area at *b* may be represented by *ab*, perpendicular to the element of surface *ef*. This can be resolved into the two forces *cb* and *ac* acting, respectively, on the horizontally and vertically projected areas of *b*, but not increasing the pressure on the bottom area. In vessel *C*, on the contrary, *ac* acts upward, and there being nothing but the bottom to oppose the downward reaction, the pressure on the bottom is increased, and the sum of these reaction pressures makes the total pressure on the bottom the same as in *A* and *B*. In vessel *D*, the pressure due to the water in tube *a* is transmitted equally everywhere. J. J.

CONTINUED FRACTIONS

P. O. R.—What are continued fractions and of what use are they?

A.—Consider the fraction $\frac{453}{1908}$. Dividing both numerator and denominator by the numerator, this fraction becomes $\frac{1}{4\frac{96}{453}}$.

Similarly, $\frac{96}{453} = \frac{1}{4\frac{69}{96}}$; $\frac{69}{96} = \frac{1}{1\frac{27}{69}}$; $\frac{27}{69} = \frac{1}{2\frac{15}{27}}$; $\frac{15}{27} = \frac{1}{1\frac{12}{15}}$; $\frac{12}{15} = \frac{1}{1\frac{1}{4}}$.

Consequently,

$$\frac{453}{1908} = \cfrac{1}{4+\cfrac{1}{4+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{4}}}}}}}$$

This is frequently written $\frac{1}{4}+\frac{1}{4}+\frac{1}{1}+\frac{1}{2}+\frac{1}{1}+\frac{1}{1}+\frac{1}{4}$.

It will be noticed that the numerators are all 1's and the denominators are the quotients obtained by dividing the different denominators by the corresponding numerators; all such expressions are called continued fractions. A continued fraction is most conveniently evaluated in the following manner: $\frac{0}{1}, \frac{1}{4}, \frac{4}{17}, \frac{5}{21}, \frac{14}{59}, \frac{19}{80}, \frac{33}{139}, \frac{151}{636}$. Write the fraction $\frac{0}{1}$ and then the first fraction in the continued fraction; in this case, $\frac{1}{4}$. Multiply the numerator of the second fraction by the next denominator in the continued fraction and add the numerator of the preceding fraction; thus, $4 \times 1 + 0 = 4$. Do likewise with the two denominators; thus, $4 \times 4 + 1 = 17$. Write the results as the numerator and denominator of a new fraction, as shown. Multiply the numerator of the fraction last found by the next denominator in the continued fraction and add the preceding numerator to form the numerator of a new fraction; thus $1 \times 4 + 1 = 5$. Do likewise with the denominators; thus, $1 \times 17 + 4 = 21$. Proceed in this manner with the remaining denominators in the continued fraction. The last fraction is equal to the original fraction when reduced to its lowest terms. The fractions following $\frac{0}{1}$ are called convergents, and each is nearer in value to the original fraction than any that precedes it. Continued fractions are used principally to obtain approximate fractions that will be sufficiently accurate and at the same time more convenient than the original fraction or decimal. For example, suppose it were desired to calculate the change-gears for a lathe to cut screw threads in the metric system. Here 1 centimeter = 0.3937 inch = $\frac{3937}{10000}$ inch. Converting this into a continued fraction, the result is $\frac{1}{2}+\frac{1}{1}+\frac{1}{1}+\frac{1}{5}+\frac{1}{1}+\frac{1}{3}$. Note that the last denominator is almost, but not quite 3; it is really $\frac{1}{79}$ less than 3. Forming the convergents as before, they are $\frac{0}{1}, \frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{11}{28}, \frac{13}{33}, \frac{50}{127}$. The last fraction reduced to a decimal becomes 0.3937008, showing that the number of teeth in the gears should be 50 and 127, provided there is no reducing gear. It is well to note that each convergent is a fraction in its lowest terms. J. J.

CALCULATING CHANGE-GEARS FOR FRACTIONAL THREADS

Mechanic.—Please explain how to calculate the change-gears for cutting screw threads when the pitch is expressed decimally; for example, suppose the lead-screw has four threads per inch and the number of threads per inch to be cut is 14.083.

A.—We suspect that in this case the decimal 0.083 is intended to be equivalent to $\frac{1}{12}$, in which event, $\frac{4}{14\frac{1}{12}} = \frac{48}{169}$.

Hence, the gear on the lead-screw should have 169 teeth and the gear meshing with it 48 teeth. Suppose, however, that the number of threads per inch required had been 14.183. The first step is to decide the limit of accuracy. The true pitch required is $\frac{1}{14.183} = 0.07050694 +$ inch. Suppose it is decided that the nearest ten-thousandth of an inch is close enough; then the gears must be so selected that the pitch of the screw will be 0.0705 ± 0.00005 inch. In other words, it must be greater than 0.07045 and less than 0.07055. The second step is to convert the decimal into a continued fraction. Thus, $0.183 = \frac{1}{5}+\frac{1}{2}+\frac{1}{6}+$, etc. Forming the various convergents, we obtain $\frac{1}{5}, \frac{2}{11}, \frac{13}{71}$, etc. Now $\frac{1}{14\frac{2}{11}} = \frac{11}{156} = 0.07051282 +$ inch, which is within the limits. Therefore, $\frac{4}{14\frac{2}{11}} = \frac{44}{156} = \frac{22}{78}$; hence, the gear on the lead-screw must have either 156 or 78 teeth, and the gear meshing with it either 44 or 22 teeth. If the third convergent be used, the pitch will be $\frac{1}{14\frac{13}{71}} = 0.07050645 +$ inch, which, as will be observed, is far more accurate. The ratio of the gears in this case is $\frac{4}{14\frac{13}{71}} = \frac{284}{1007}$. Since this fraction cannot be reduced any further, and as it is impracticable to make a gear having 1007 teeth, this ratio is valueless for a simple geared lathe. It can be used, however, with a compound geared lathe, since $\frac{284}{1007} = \frac{4}{19} \times \frac{71}{53} = \frac{16}{76} \times \frac{71}{53}$. That is, gear 16 would be on the spindle and would mesh with gear 53 on the stud; gear 76 would be placed on the lead-screw; gear 71 would be on the same shaft as gear 53, and would mesh with gear 76. J. J.

INFLUENCE OF TRADE PAPERS IN FOREIGN TRADE

In a paper read at the convention of the Associated Advertising Clubs of the World in Philadelphia, June 27, C. A. Tupper, president of the Chicago Trade Press Association, said he could best point out the opportunities that lie before American trade and technical journals to help build up foreign trade, by giving specific examples of what they have already accomplished.

Some years ago he visited the principal industrial countries of the world outside of the United States and Canada, his work taking him into practically every manufacturing district of importance, with particular reference to mining, metal working, woodworking, electrical and textile plants, as well as to large construction projects and the mills or factories furnishing material for them. Docks and shipyards were also visited. In the metal working plants he found an amazingly large number of installations of American built machine tools. Upon inquiring into their origin, he learned that in the majority of cases the equipment had been bought by the German, Swiss, French or English proprietors, rather than sold to them by American manufacturers or their agencies. The distinction is important. Herein lies one of the strongest reasons for the tremendous influence which American trade and technical journals have exercised on foreign trade.

Among these metal working plants he found MACHINERY, the *Iron Age, and American Machinist* extensively circulated. Furthermore, they were eagerly and intelligently read. When a new machine tool was put upon the American market, both the editorial and advertising descriptions were closely followed by a considerable number of foreign shop owners, who studied the possible application of such a machine to their own operations with great care. In many cases such articles and advertisements subsequently led to visits to the United States by representatives of large foreign metal working interests and to considerable purchases of American tools for use abroad. In other cases correspondence developed with the American manufacturers which led directly to orders by mail.

At the present time many American machine tool manufacturers are represented abroad by active sales agencies, but the business was originally developed almost entirely through the initiative of the foreign buyer after reading descriptions of the tools in American journals.

In Germany and Austria-Hungary, before the war, there were large installations of American rock and ore crushing machinery, steam and electric shovels, and heavy construction equipment, the orders for which, Mr. Tupper says, were directly traceable to the influence of American trade journals. At the Lousavaara-Kirunavaara iron mines of Lapland and in the frozen island of Spitzbergen, which is far within the Arctic Circle, beyond Norway, extensive coal and iron ore mining and ship loading equipment had been bought from advertisements. In Spain and other countries of Southern Europe, advertisements led to contracts for complete cement mill equipments. On the historic island of Elba, there is a blast furnace plant where the blowing engines were constructed after the designs of a Philadelphia concern, as a result of a description in a trade paper, which led to a visit from the company's engineer to plants in eastern Pennsylvania. In northern Algeria there is equipment for mining and handling phosphate rock which was bought on advice taken from the pages of an American magazine.

In riding from Cologne to Berlin Mr. Tupper conversed with a German wholesale lumber dealer having large interests in the eastern provinces. This dealer read an American trade journal very carefully and purchased most of the equipment of his saw mills located in East Prussia and Silesia as the result of advertisements appearing in that paper.

In Vienna he was shown an article contributed to one of the papers in which he is now interested, and was asked whether he was the same Herr Tupper who had written it. Upon admitting that he was, an official asked him questions in considerable detail about the ore washing plant of the Oliver Iron Mining Co. at Coleraine, Minn., and negotiations were later started with American manufacturers for a plant in Transylvania, the completion of which has been delayed by the war. At Gohlis, a suburb of Leipsic, Germany, he had a similar experience with another article, which had been clipped, filed and carefully indexed. The concern that he visited there subsequently sent to him at Milwaukee a representative of the Prussian government who was interested in handling equipment for loading and unloading at wharves. This man brought out a portfolio containing clippings, both articles and advertisements, which he had gathered from American journals he had read in Germany.

But aside from the direct contact of American trade and technical journals with the foreign customer, it must be remembered that an influence of considerable importance is being exerted by the re-publication in foreign trade and technical journals of articles from American papers of the same class. An examination of copies of papers issued in Europe, Asia, South Africa, Australia and Latin America shows that reprints from American papers form a large percentage of the contents of such papers, and in many cases overshadow the original material used in them.

* * *

NEW FRENCH AEROPLANES

A new type of aeroplane has been brought out in France, which has wing planes about 75 feet wide. There are three planes arranged vertically one above the other, the total height of the triplane being about 20 feet. This triplane has a seating capacity for twelve people, but ordinarily does not carry more than six. The aeroplane is equipped with four 1½-inch rapid-fire guns, and has a speed of over 80 miles an hour. In addition to these aeroplanes, which are intended primarily for attacks on enemy positions by means of bomb dropping, a fleet of aeroplane destroyers has also been developed. These aeroplanes are, strictly speaking, battle planes, intended to attack enemy aeroplanes in the air. This type consists of a biplane, 7 feet high, with wings 21 feet wide, having a maximum speed of 100 miles an hour. These biplanes are equipped with rapid-fire guns which can be operated by the aviator himself. It is claimed that these aerial destroyers excel all aeroplanes hitherto built as regards ease of manipulation. They can rise in a helix of very small diameter, and in forty seconds are able to reach a height of 3000 feet. The steering gear is manipulated by pedals, so that the aviator has his hands perfectly free for making notes and sketches, or for the operation of the rapid-fire gun. Previous to the war France built yearly from 150 to 200 aeroplanes. At the present time it is stated that one factory alone completes five aeroplanes daily.

* * *

SPEED OF WOODWORKING MACHINERY

There is considerable difference of opinion as to the speed of woodworking machinery, and machinery of this type is often run at too low a speed for the best efficiency. There seems to have been less effort made in instructing the users of woodworking machinery as to the proper speeds to employ than in the metal working industries. Woodworking machinery requires comparatively high power, owing to the fact that it should be run at a high speed, and, while the material cut is so much softer than that cut in metal working machinery, the amount of material removed per minute is so much greater that the power for machines of approximately the same size does not differ materially. A properly driven circular saw, according to the *Railway and Locomotive Engineer*, should run at a peripheral speed of 7000 feet per minute—nearly a mile and a half. A band saw is run at about half that speed. Planing machine cutters have a speed at the edge of 6000 feet per minute, as the cutters of molding machinery trim out material at about 4000 feet per minute. Wood carving drills run at 5000 revolutions per minute. Augers 1½ inch in diameter are run at 900 revolutions per minute, and those half that size are run at 1200 revolutions per minute. Mortising machine cutters make about 300 strokes per minute.

* * *

Thin brass tubing is threaded with twenty-seven threads per inch, irrespective of diameter. The so-called ornament brass sizes have thirty-two threads per inch.

RIVETT AUTOMATIC OSCILLATING GRINDING MACHINE

The great increase in the use of ball bearings and the accompanying demand for grinding machines has led the Rivett Lathe & Grinder Co. to bring out the oscillating grinder illustrated herewith. Its principal features are the automatic oscillation of the head, positive methods of adjustment and range of feeds necessary for good ball bearing race grinding.

The Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has brought out the automatic oscillating grinder illustrated herewith. This machine is adapted for grinding concave and convex rings, and especially for finishing ball bearing races to the highest degree of accuracy. The machine is protected by Van Norman patent, reissued March 16, 1915, No. 13,892, under which the Rivett Lathe & Grinder Co. is licensed to manufacture.

Fig. 1 shows a view of this machine from the front; Fig. 2 shows a front elevation; Fig. 3 represents a cross-section taken through the oscillating post; Fig. 4 shows the gear-box; Fig. 5 is a section through the wheel-spindle slide; and Fig. 6 shows the drive from the countershaft to the wheel-spindle and the belt adjustment. It is recommended that this machine be used for work within a limit of 3½ inches diameter, although the actual swing of the work-spindle is 7 inches with the front guard removed. The spindle will swing 5½ inches over the guard, but the best work is limited to sizes within 3½ inches diameter.

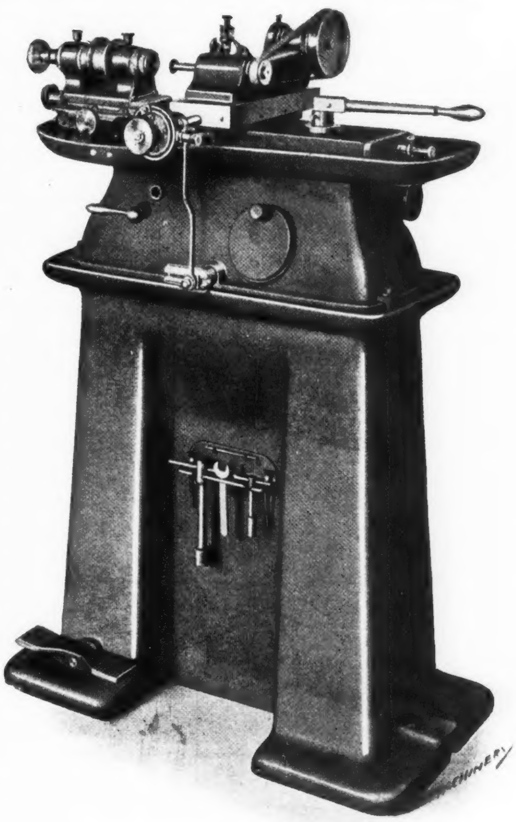


Fig. 1. Rivett Automatic Oscillating Grinding Machine

The Oscillating Mechanism

The oscillation of the work-head takes place about the post which may be seen at the left-hand side of Fig. 2. By referring to this illustration in connection with Fig. 3, which shows the oscillating post and adjacent mechanism in section, the method of oscillating the head may be seen. The oscillating head which carries the work-holding spindle is held to the top of the oscillating post by means of screws and dowels. The upper end of the post is mounted in a double taper bronze bearing which adequately supports it and keeps it free from play, while the lower end is mounted in an annular ball bearing that steadies the post with a minimum of friction. Below the lower bearing on the oscillating post is a flange that takes up end play, and above the ball bearing is a protecting flange. Located directly above this flange is the oscillating bracket that runs free on the post. This bracket oscillates constantly, and the post and its work-head are made to move in unison with it by engaging the clutch that may be seen above the bracket. This clutch is slidably mounted on the oscillating post by means of two pins that extend from the adjustable sleeve on the post down into holes in the clutch. The sleeve above the clutch is adjustable on the post; therefore, the center of oscillation may be changed at will by loosening this sleeve and changing its position. The advantage of being able to stop oscillation without stopping the entire machine is apparent, and especially valuable when adjusting or setting up the machine.

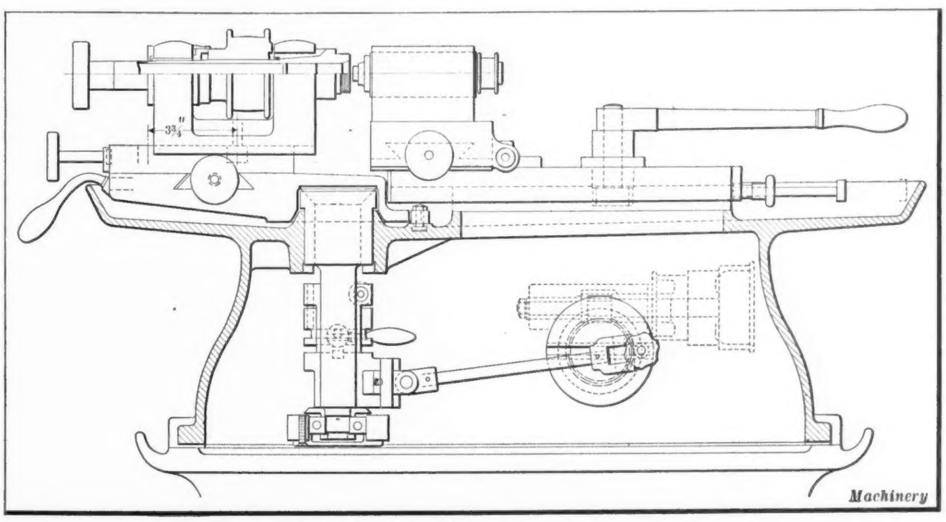


Fig. 2. Partial Front Elevation of Machine shown in Fig. 1

The work-spindle head is laterally adjustable on the oscillating head so as to secure movement at any desired radius from the axis of oscillation to provide for grinding any depth of groove. The work-spindle is of the regular Rivett construction, being made of tool steel and running in hardened and ground steel bearings. The thread on the spindle nose is 1⅝ inch diameter by 12 pitch, and is finish-ground on the spindle bearing. The spindle end is provided with a taper for receiving No. 4 new style standard Rivett chucks. Adequate oiling provisions are present for lubricating the bearings. The driving belt to the work-spindle and wheel-spindle countershaft is operated from an overhead countershaft which was described in the March, 1915, number of MACHINERY. A foot control at the base of the machine may be fitted to operate the countershaft, and by means of a brake that acts almost instantly the oscillation may be stopped within a limit of 10 degrees.

Method of Oscillation

Fig. 4 best illustrates the mechanism employed for oscillating the bracket on the oscillating post. The drive is received from the overhead countershaft on the three-step cone pulley *A* on the back-shaft. This back-shaft carries a worm *B* that meshes with a worm-wheel *C* on a shaft *D* at right

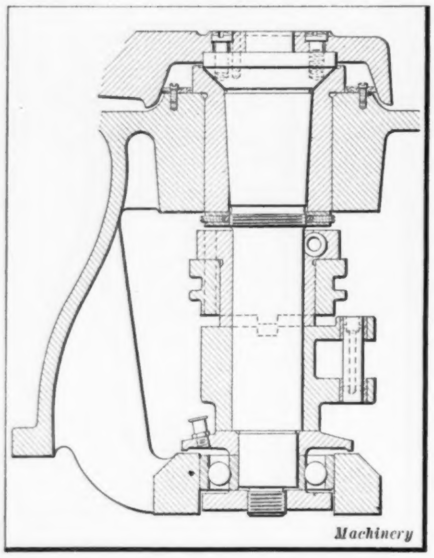


Fig. 3. Cross-section through Oscillating Post

angles to the back-shaft and enclosed in the column of the machine. This worm-shaft terminates in a crank disk E that is slotted and provided with a pin F carrying a lever G that connects with the oscillating bracket. At each end of this connecting-rod are universal joints, bronze-bushed. The maximum amount of oscillation that may be obtained is 120 degrees, and any amount of oscillation may be obtained by adjusting pin F in the slot in crank disk E.

Carriage and Wheel-slide Mechanism

As may be noticed from Fig. 2, the carriage of this machine has an extremely long bearing on the ways, and the wheel-slide table and wheel-slide are mounted on the carriage. By means of the hand-lever that may be seen in Figs. 1 and 2, the carriage may be moved longitudinally for a distance of 2½ inches. This movement is secured by a rack and pinion. At the rear of the carriage is an adjustable stop that can be set to bring it into position after withdrawal for gaging work, etc.

The mechanism by which the wheel-slide is automatically cross fed may best be understood by reference to Fig. 5 that shows the wheel-slide table and base of the wheel-slide in section. The long screw that traverses the wheel-slide is provided with a section H at the end, having a 12½-pitch, left-

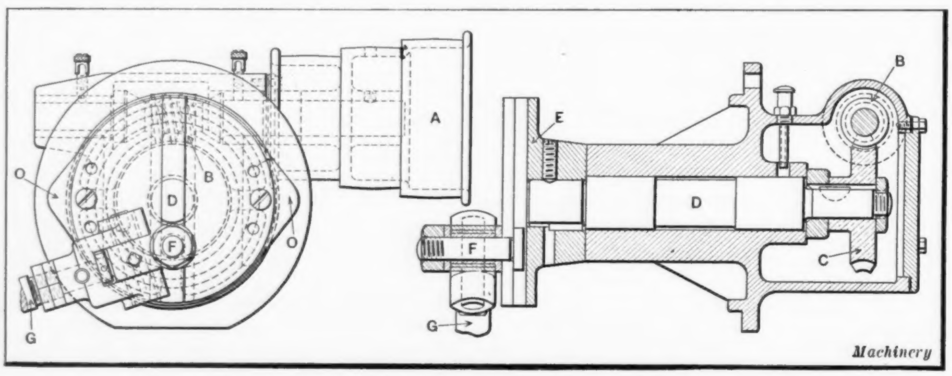


Fig. 4. Longitudinal and Cross-sectional Views of Gear-box

hand Acme thread that engages a solid nut I, bolted to the extreme end of the carriage. Midway of the screw is a section J that is threaded with a 10-pitch, left-hand Acme thread, and this section engages a nut K screwed to the under side of the wheel-slide table. It is obvious that every full revolution of this screw will advance or withdraw the wheel-slide an amount equal to the difference in pitch of the two threaded sections of the screw, or 0.020 inch.

The control end of this screw passes through a bushing L held in the extension bracket M of the carriage, and thence to the front of the machine. On the outer part of this screw is a double ratchet N having 200 divisions or teeth. The teeth on one side of the ratchet are cut left hand, and on the other side right hand, to provide for feeding in either direction. The feed pawl that gives the impulses to the ratchet, and hence to the screw, has two teeth that are spaced 1½ times the pitch of the ratchet teeth. Therefore, it is possible to turn the screw at each interval by as small an amount as 1/400 part of 0.020 or 0.00005 inch.

The automatic feed for the wheel-slide is not shown in the line engravings, but a good idea of its operation may be obtained from the halftone illustration Fig. 1, in connection with

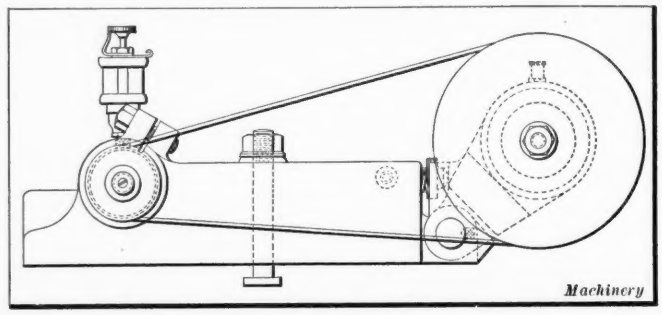


Fig. 6. Drive from Countershaft to Wheel-spindle and Method of adjusting Belt Tension

the line illustration Fig. 4. The latter view shows the method of actuating the automatic feed cams that give rise to the impulses for operating the cross-feed. On the face of the crank disk illustrated in Fig. 4, there is a double cam, the rises O of which operate a bellcrank lever that terminates at the outside of the machine in the slotted lever shown in Fig. 1. It is evident that the double-rise cam rocks this lever twice during each rotation of the crank disk each time an impulse is given to the feed-rod that carries motion up to the pawl meshing with the ratchet on the cross-feed screw. These two impulses operate the feed at each end of the oscillating stroke. It is possible to remove one of the cams if desired, so that the feed is operated only at one end of the oscillation. The feed-rod operating lever is slotted so that any amount of feed from 0.00005 inch up may be secured.

Wheel-spindle and Drive

Fig. 6 gives a good idea of the wheel-spindle mounting and its drive, especially when viewed in connection with Fig. 1. The wheel-spindle itself is a unit mounted on two standard ball bearings and is quickly removable from its housing by loosening the clamping nut shown in Fig. 6. The drive is through an endless canvas belt to the large pulley on the ball bearing countershaft. This ball bearing countershaft is pivoted on the wheel-slide table as shown. The belt tension is adjusted by increasing or diminishing the angle of the countershaft by means of the adjusting screw shown.

The base of this machine is provided with a generous water pan, and the machine can be fitted with water pump if desired. Doors are provided on the machine as well as the pedestal

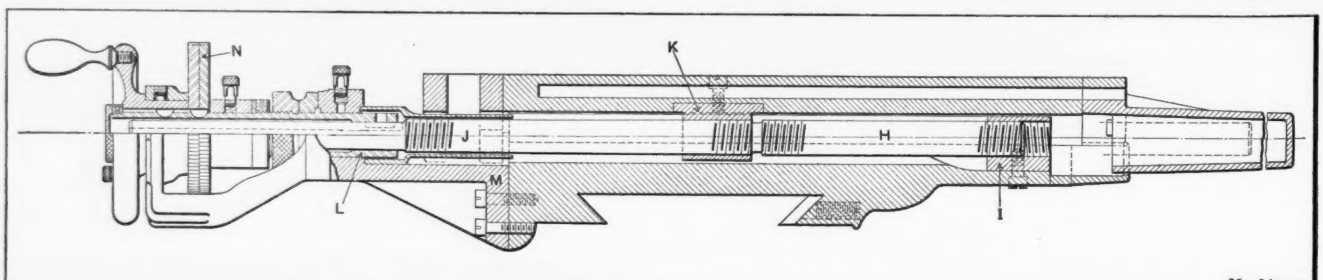


Fig. 5. Cross-sectional View through Wheel-spindle Slide

base, so as to afford ready access to the mechanism. The upper part of the grinding machine is mounted on the base casting on the three-point principle, thus obviating any twisting tendency.

Three wheel speeds are provided, those recommended being 11,600, 16,000 and 19,200. The work-head is provided with two speeds, those recommended being 300 and 590. The main shaft of the countershaft is run at a speed of 600 revolutions per minute.

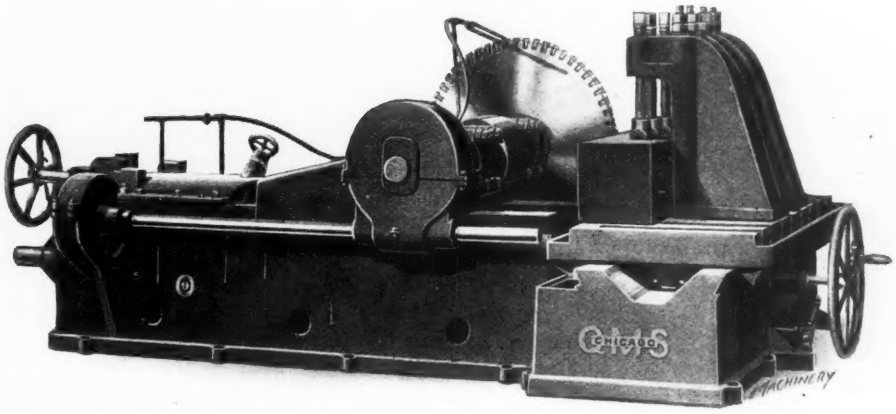


Fig. 1. Q. M. S. Cold Metal Saw for which Vulcan Engineering Sales Co. is Selling Agent

VULCAN COLD METAL SAW

Figs. 1 and 2 show rear and front views of an improved type of cold metal saw built by the Q. M. S. Co., and for which the Vulcan Engineering Sales Co., 2059 Elston Ave., Chicago, Ill., has the sales agency. The saw and gear arbors are hammered 60-point carbon open-hearth steel and scraped to accurate fits. The teeth are cut from the solid steel, and they are staggered for the purpose of reducing backlash and chatter to a minimum. The saw and gear arbors run in hard bronze bearings. A worm and wheel type of drive is employed, the worm being made of hardened steel and the wheel of a special mixture of bronze. The thrust of the worm is taken by roller bearings; and the worm-wheel is of two-piece construction, consisting of a steel center around which is shrunk a bronze rim. The worm and worm-wheel are enclosed and run in grease.

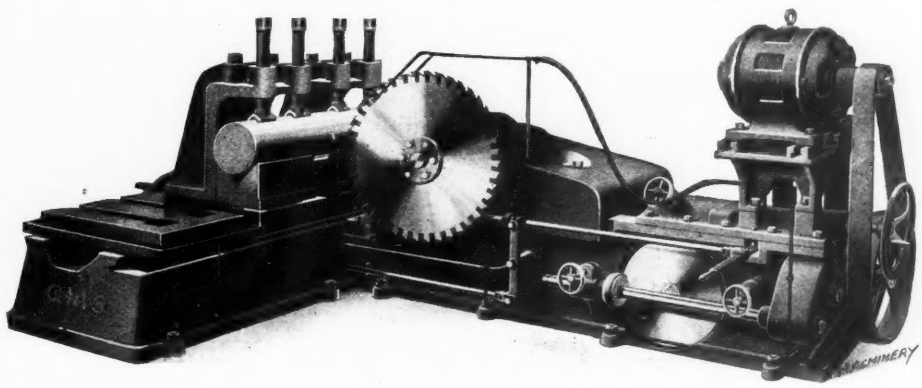


Fig. 2. Front View of Q. M. S. Cold Saw shown in Fig. 1

The carriage is of box section and is scraped to an accurate fit on the ways. It has a full length bearing, and taper gibs provide means of compensating for wear. Hand adjustment, automatic stops and quick power return are features of the design. Feed is obtained by the combination of a friction disk and gears, which give a range of feeds from 5/16 inch to 2½ inches per minute. The friction feed wheel automatically sustains the proper contact with the friction disk, thus insuring maximum power. Changes in the peripheral cutting speed of the saw may be instantaneously made, and machines are provided for running at 30 and 50 feet per minute or 40 and 60 feet per minute, according to the requirements of the work on which the saw is to be employed.

A feature of the machine is that all levers for controlling the feed, peripheral speed and return motion are concentrated in a position where they can be conveniently reached by the operator. The levers for engaging the feed and quick return are extended through the machine, so that control is obtainable from either side. All gears on the machine run in oil, and all internal bearings are lubricated by oil pipes leading to the exterior of the machine. An oil trough is cast around the work-table, and a gear-driven pump provides for delivering lubricant to the saw table. The base of the machine is a box-section casting, and the ways are carefully machined and scraped to an accurate fit. Turned shafting is used throughout the machine.

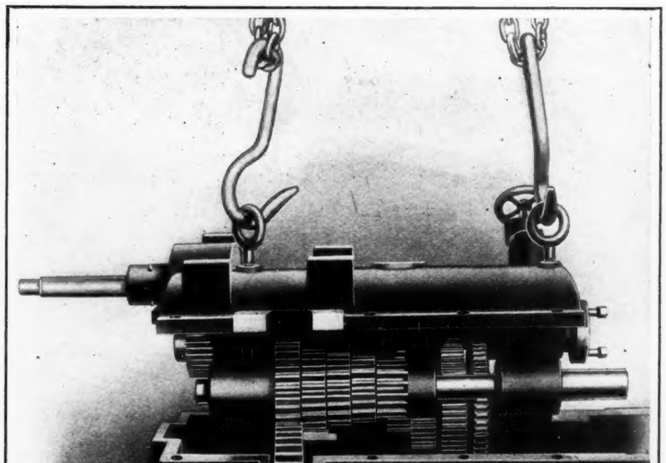


Fig. 3. How Mechanism is supported by Cover to facilitate Quick Removal

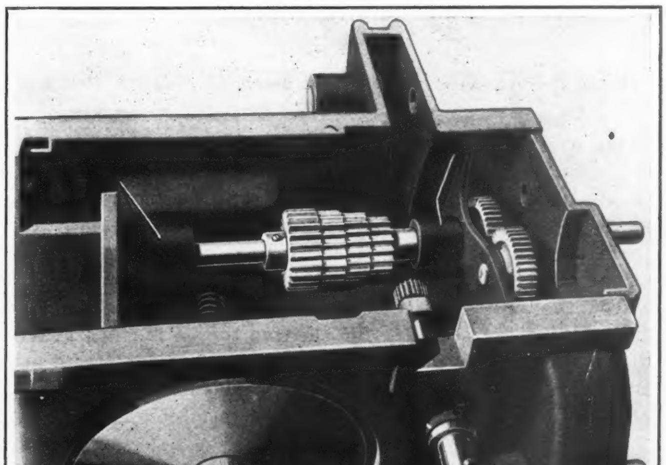


Fig. 4. View of Mechanism in Bed with Cover removed—Attention is called to Oil Pipes leading to Bearings

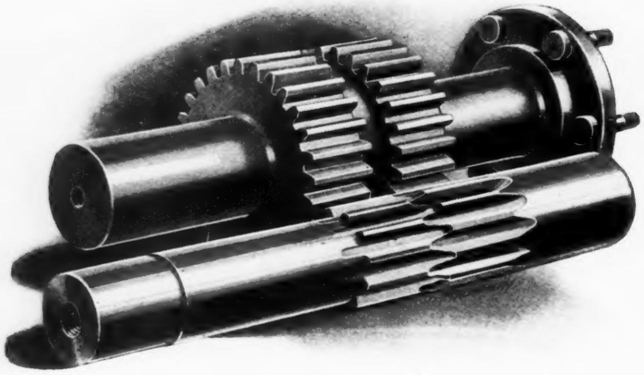


Fig. 5. Close View of Staggered Tooth Construction on Saw and Gear Arbors

The power provided is sufficient to enable the manufacturers to guarantee that the machine will drive to the limit of its cutting capacity all sizes of inserted-tooth saws that come within its range.

C & C DIRECT-CURRENT MOTORS

The C & C Electric & Mfg. Co., Garwood, N. J., has developed a line of electric motors especially adapted for those classes of service where direct-current motors of the smaller horsepowers are required for direct-connected motor drive on machine tools and other types of industrial machines. They are known as Type I-B and are of the bi-polar type with interpoles. The line includes motors up to ten horsepower capacity, and they can be furnished either shunt- or compound-wound, according

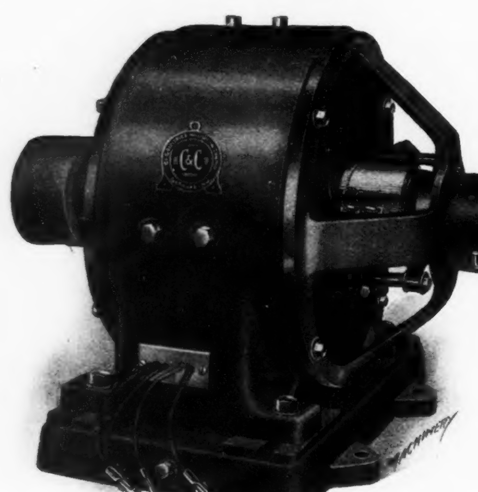


Fig. 1. Type I-B Motor with Universal Base made by C & C Electric & Mfg. Co.

to the requirements of the shop in which they are to be used. For driving machine tools and similar classes of service, the shunt-wound motors are said to be most satisfactory, as the service required is essentially one of constant speed with close speed regulation from no load to full load, and where the torque required for starting and accelerating does not greatly exceed the full load torque. The compound-wound motor is desirable for drives where the starting torque is much heavier than the full load torque, as this type of motor starts at a much heavier load than the shunt-wound motor, and any degree of compounding can be furnished to meet existing conditions. Adjustment of speed is obtained in both types of motors by either armature or field control.

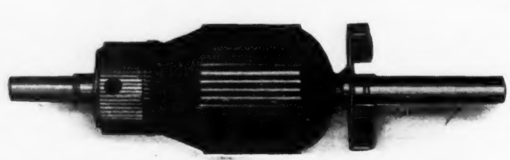


Fig. 2. Armature of C & C Type I-B Electric Motor

The main frame and supporting feet are cast integral and the pole pieces are separate. The main pole pieces and pole shoes are laminated, with the interpole pieces cast separately, and the coils are form wound. The pulley side bearing bracket is provided with a wide apron to protect the windings from mechanical injury, and the bearing is supported by four arms with large openings between them, making a rigid open bracket and permitting free and ample ventilation. The commutator side bearing bracket has four arms, giving free access to the commutator and brushes. Both brackets fit in recesses in the main frame, thus insuring perfect and rigid alignment.

The armature is of standard design with a laminated core; and an air-agitating fan is placed on the pulley end of the shaft next to the armature windings, in order to provide the high degree of ventilation and cooling which is absolutely necessary in motors of compact form to guarantee satisfactory operation under severe service and a heavy overload capacity. The addition of interior commutating poles completes the constant characteristics of these motors. Under continuous operation for long periods of time, it is stated that these motors run cool and do not require any attention. The interpoles insure sparkless commutation through the full range of load without changing the brush position. These motors may be furnished in the open type or with perforated or totally enclosing covers to provide protection against dust, metal chips, dampness, etc. For use in connection with belt drive, the motors can be provided with either a universal slide-rail base or a belt tightening idler pulley for adjusting the belt tension.

Fig. 3. Main Frame with Field and Commutating Poles of C & C Type I-B Electric Motor

"FULFLO" GRINDER PUMP

The Cincinnati Lubricant Pump Co., 126 Opera Place, Cincinnati, Ohio, has added to its line of "Fulflo" pumps a lubricant pump of the centrifugal type which is especially adapted for use in delivering water to grinding wheels. The centrifugal principle employed has been applied in such a way

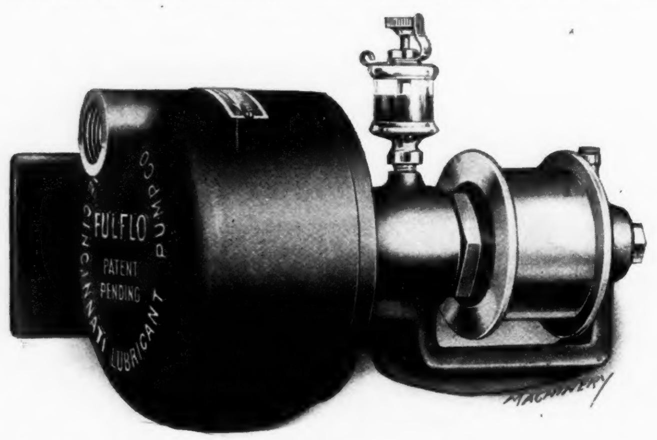


Fig. 1. "Fulflo" Centrifugal Grinder Pump made by Cincinnati Lubricant Pump Co.

that the delivery of a large volume is assured without having the water supplied under too great a pressure. The pump can be mounted above the level of the water, and owing to its positive trap arrangement, it will retain its "prime" without requiring the use of a check valve. The possibility of mounting

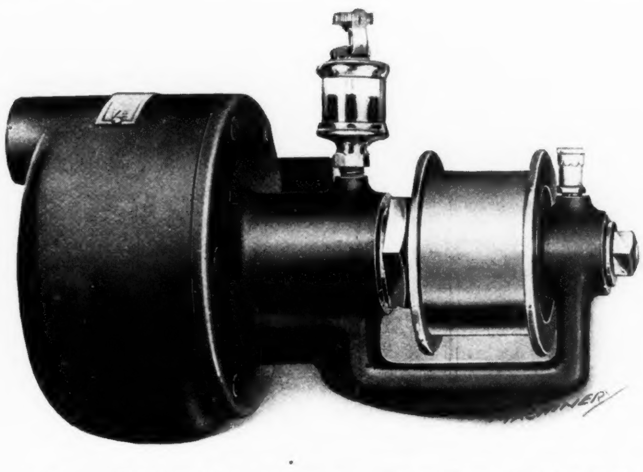


Fig. 2. "Fulflo" Grinder Pump, showing Clearer View of Driving Shaft Pulley and Bearings

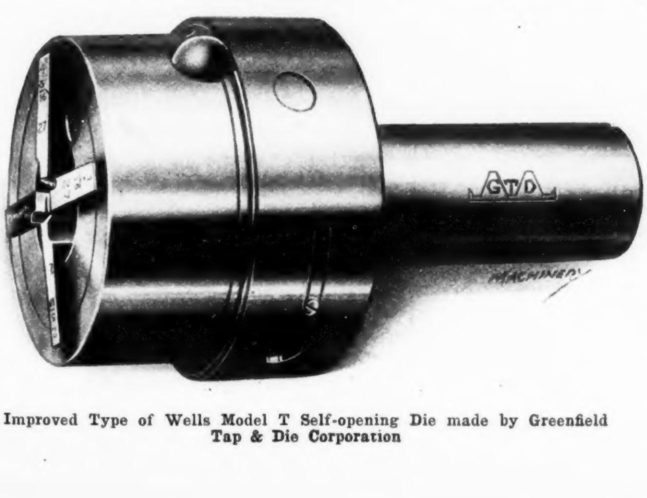
the pump above the surface of the water enables it to be placed in any convenient position on the grinder with regard to convenience, accessibility, etc.

The "Fulflo" grinder pump has no bearings in the pump proper, the impeller which is the only working part being mounted on the driving shaft. Since it has no contact with any other part, the impeller will last and retain its full efficiency almost indefinitely. As no gears or other close fitting parts govern the action of the pump, its efficiency is not affected by the presence of emery grit and dirt in the water. All passages are made of large size so that they are not likely to become clogged. The driving shaft is made of hardened and ground steel and is supported by bearings at both sides of the driving pulley. The outer bearing, which also supports the end thrust, is made of phosphor-bronze. The inner bearing is combined with the stuffing-box gland and is made of cast iron. This inner bearing is protected from emery grit and dirt by the use of a combination of metallic graphite, rubber and flax packing which is non-granular and will not cut the shaft, although it prevents the slightest particles of grit or dirt from reaching the bearing.

Large oil reservoirs provide semi-automatic lubrication for the bearings. When pulley-driven and using a suction-lift of twelve inches and a head-lift of four feet, the rates of delivery are about as follows: for 1200 revolutions per minute, five gallons per minute; for 1400 revolutions per minute, ten gallons per minute; and for 1600 revolutions per minute, fifteen gallons per minute. In order to increase the flow for a given head-lift, or to secure the same flow for a greater head-lift, it is simply necessary to increase the speed of the pump pulley proportionally.

GREENFIELD SELF-OPENING DIE

The Greenfield Tap & Die Corporation, Greenfield, Mass., has recently made several important changes in its model T Wells self-opening die. The improved tool is shown in the accompanying illustration, where it will be noticed that the openings for the chaser set-screws, which were formerly exposed, are now entirely covered by a light steel shell, thus eliminating the possibility of fine chips entering and interfering with the work. Although this steel shell affords ample protection, it can be instantly turned to expose the screws so that the chasers can be released and removed in the usual way.

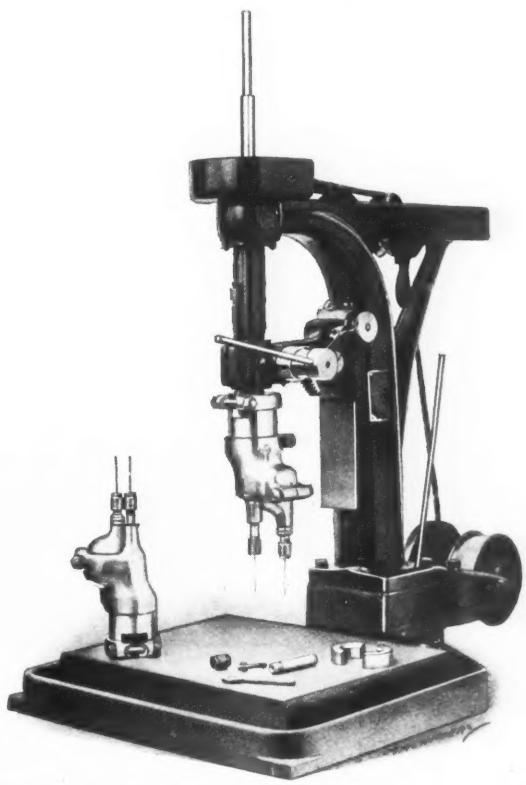


Improved Type of Wells Model T Self-opening Die made by Greenfield Tap & Die Corporation

This improved threading die is especially adapted for operations in which the die is required to revolve; and on this account the old style of projecting face trip has been discontinued, a neat and serviceable ball shaped latch at the side of the die-head now being employed to release the chasers when the cut has been taken. The well-known self-opening die principles and all essential points of construction of the previous type of model T Wells self-opening die have been retained in the present design, which also includes the improved features referred to.

SELLEW SENSITIVE DRILL HEAD

The illustration presented in connection with the following description shows a Leland-Gifford high-speed bench drill equipped with a sensitive adjustable drill head which is a recent product of the Sellew Machine Tool Co., Pawtucket, R. I. The center spindle of this head is directly connected with the main driving spindle, and the auxiliary spindle is adjustable; the minimum distance is 0.6 inch and the maximum distance 1.7 inch between centers of the spindles in the head. The chucks have a capacity for holding drills up to



Leland-Gifford High-speed Bench Drill equipped with Sellew Sensitive Drill Head

1/8 inch in diameter, and they are an integral part of the spindles. The auxiliary spindle has its own thrust bearing, and the center or main driving spindle is connected to the spindle of the drilling machine. Drill heads of this type are particularly suitable for brass work, especially in the manufacture of ammunition; and they provide for drilling two holes simultaneously, so that it is unnecessary to shift the drill jig.

Although the drill head illustrated in this connection is only provided with one auxiliary spindle, this type of head is also made in what is known as a "double" type which has auxiliary spindles on both sides of the center spindle, thus permitting of the performance of drilling operations where it is necessary to produce three holes simultaneously. These holes are located in a straight line and spaced equidistant from each other, the distance between centers being anything which comes within the range of the machine. The connecting sleeve on the drill head is clamped to the quill of the drilling machine just above the spindle ball bearing; and the head can be rotated around the center axis in order to bring the auxiliary spindle into any required position.

PIERCE PLAIN-HEAD SCREW MACHINE

The machines shown in Figs. 1 and 2 are of essentially the same design, except that the machine shown in Fig. 1 is equipped with a collet chuck, bar feed mechanism and a stock support to form the hand screw machine, while on the machine shown in Fig. 2 these features have been dispensed with to form a turret lathe. The screw machine has a capacity for handling round stock up to 1 1/16 inch in diameter, and work up to 8 inches in length can be turned. On both the screw machine and turret lathe the swing over the bed is 14⅛ inches.

The Pierce Machine Tool Co., 617 W. Jackson Blvd., Chicago, Ill., has recently placed on the market a 1- by 8-inch heavy-pattern turret screw machine with a plain head. It will be seen that the headstock is of the "bowl" type and cast integral with the bed of the machine. Ample belt clearance is provided between the "bowl" and the three-step cone pulley. The spindle is made of high-carbon hammered crucible steel; it is bored from a solid forging and accurately ground to size. The spindle is carried in phosphor-bronze bearings, which are furnished with sight-feed oilers; and the automatic chuck is forged solid on the end of the spindle, the design being such that overhang from the front spindle bearing is reduced to a minimum. The stock feed, which is positive in operation, is controlled by a conveniently located lever, the work being gripped or released at any desired point. The stock can be fed directly into the chuck while the machine is in operation. A stepped wedge automatically compensates for variations in diameter of bar stock or casting; and a guard fitted over the rear end of the spindle prevents the throwing of oil from revolving parts. The wire feed dog is fitted with a guard to afford protection from the set-screw in the revolving stock collar; and this also prevents the throwing of lubricant that may work back along the bar. The collets are hardened and ground to size; and either a plain round collet is provided or a master collet adapted for the use of hardened and ground bushings. A plain 1-inch collet is furnished unless otherwise ordered.

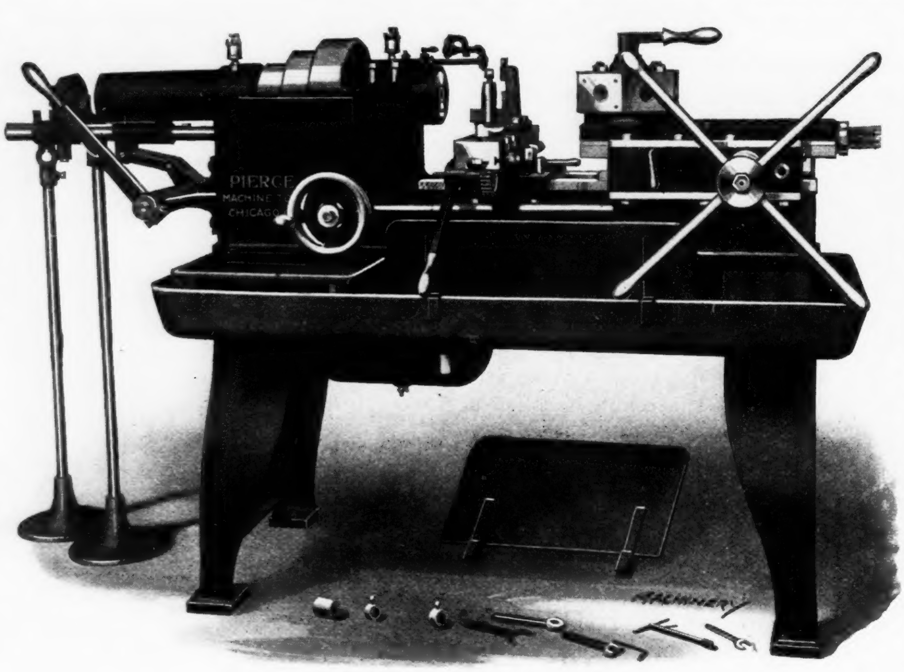


Fig. 1. Pierce 1- by 8-inch Heavy-pattern Turret Screw Machine with Plain Head

The cut-off rest is fitted with a convenient locking clamp, hand longitudinal screw feed adjustment with a micrometer dial, and means of adjusting the cut-off rest along the bed for facing, necking and similar operations. Feeding of the cut-off slide is through a rack and pinion which work in conjunction with adjustable stops. When so desired, screw cross-feed can be furnished in place of the rack and pinion feed. It will be seen that the turret is of hexagonal form, providing for the use of six tools. The holes are fitted with binder bushings unless set-screws are especially ordered. In addition, each face of the turret is provided with tapped holes for use in securing tools to the turret faces. The turret holes are counterbored to provide for receiving a boss on the back of each tool, an arrangement which permits of the accurate location of tools and the maintenance of exact alignment. The turret is automatically indexed by the backward movement of the slide, which is governed by the pilot wheel. The locking bolt is located at the front end of the slide directly beneath the cutting tool, and enters a hardened and ground taper bushing fitted into the solid turret as near the periphery as possible. Independent adjustable stops operate automatically for each position of the turret, and if desired, provision may be made for automatically releasing the power feed. A lever at the back of the saddle allows the turret to travel slightly beyond each stop when so desired, without altering the arrangement of the stops; this is a convenient feature, as it does away with trouble that would otherwise result through slight inequalities in the stock.

Positive power feed for the turret slide can be furnished as special equipment, giving four changes of feed, any of which is instantly obtainable by operating a lever located at the front of the head. The turret saddle and slide are made of ample width, and tapered gibs are fitted over the entire length of the saddle, thus providing convenient means of taking up wear. The saddle is arranged on an adjustable tapered base, by means of which perfect alignment of the turret holes with the center of the spindle can be maintained. A geared oil pump driven by a belt from the countershaft delivers an abundant flow of oil to the cutting tools, and operates when the machine is running in either direction. The oil- or chip-pan has ample capacity, and the oil-tank is cast integral with the pan; the tank being of sufficient size to hold a liberal supply of oil. It is furnished with a perforated cover which acts as a strainer and allows the oil to drain back into the tank. The countershaft is of the double friction type with ring oiling bearings. Standard equipment furnished with the machine includes an automatic chuck with one collet, a stock feed with two supports, a hand longitudinal cut-off rest with front and back tool-

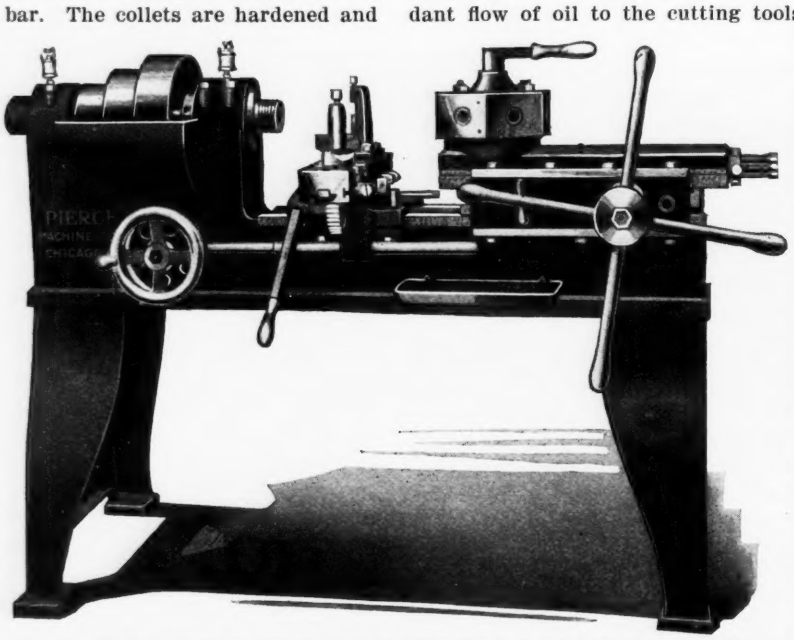


Fig. 2. Machine shown in Fig. 1, without Collet, Bar-feed and Stock Support, making 14-inch Turret Lathe

posts, a hexagon turret with binder bushings, an oil-pan and pump, a tool tray, front and back splash guards, a countershaft and the necessary wrenches for making all adjustments.

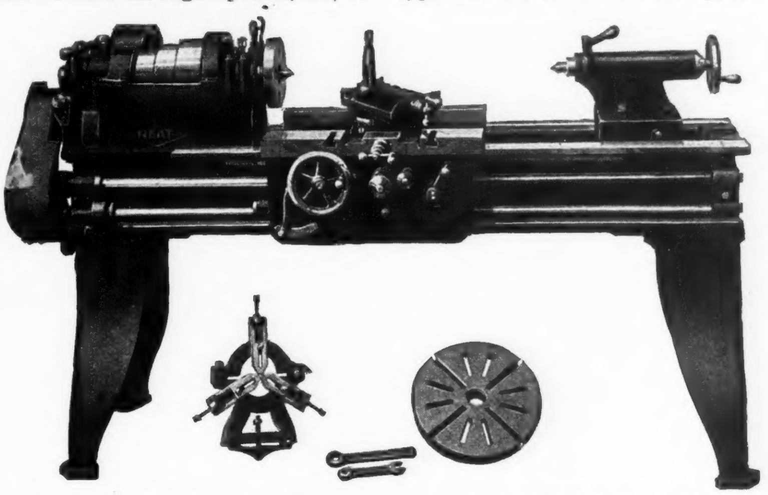
The principal dimensions of this machine are as follows: capacity of automatic chuck, for round stock up to 1 1/16 inch in diameter and for square stock up to ¾ inch; capacity for handling threaded work, up to ⅝ inch in soft steel, and up to 1 1/16 inch in brass; capacity for drilling in soft steel, up to ¾ inch in diameter; diameter of hole in automatic chuck plunger, 1 3/32 inch; diameter of hole through spindle, 1 5/16 inch; maximum length of work that can be turned, 8 inches; swing over bed, 14⅛ inches; swing over cut-off slide, 6 inches; maximum distance from end of spindle to face of turret with saddle flush, 16½ inches; diameter of holes in turret, 1 inch; size of tapped holes in face of turret, ⅜ inch; distance from center of turret holes to top of slide, 2⅜ inches; maximum cross travel of cross-slide, 6 inches; maximum longitudinal travel of cross-slide, 8½ inches; available power feeds to turret in revolutions of spindle corresponding to 1 inch of feed movement, 24, 40, 66 and 120; width of driving belt, 2½ inches; size of cut-off tool, 1 by ½ inch; extension of bar feed-rod, 3 feet, 4 inches; spindle speed for a countershaft feed of 200 revolutions per minute, 180, 285 and 480 revolutions per minute; horsepower required, 1½; floor space occupied, 2 feet, 2 inches by 5 feet; and net weight of machine without power feed for turret, 1350 pounds.

Fig. 2 shows the same machine without the collet chuck, bar feed and stock support, making a 14-inch heavy-pattern turret lathe. The design of this machine is thoroughly covered by the preceding description of various features of the hand screw machine, so that no further information is necessary to give the reader a comprehensive understanding of its various features.

"NEAT" HIGH-POWER LATHE

The National Engineering & Tool Works, 1132-1134 William St., Oak Park, Chicago, Ill., has developed what is known as the "Neat" high-power 14-inch tool-room and manufacturing lathe. As its name implies, this lathe is intended for both tool-room and general shop work, and to adapt it for heavy service all parts are liberally proportioned. The machine is driven by a three-step cone pulley and double back-gears, with a shifter lever for quickly changing the speeds. Located on the apron there is a feed-change lever; and by simply moving this lever to any one of the four positions, any of the changes of feed may be instantly obtained. The feed-rod is driven direct from the headstock by a train of gears and a safety friction is provided which will slip before damage can be done to the gears or other parts of the feed mechanism. This safety friction also provides for working the lathe to its maximum capacity without danger, as the friction will slip and prevent damage in case the tool strikes an exceptionally hard spot in the work.

The quick-change gear feature has been eliminated in designing this machine, and an unusually large number of change-gears are furnished, which makes it possible to cut a great variety of thread pitches, ranging from very coarse pitch of one thread per inch down to the finest pitches ordinarily cut on a lathe of this size. The headstock is of the "bowl" type which forms a direct support between the front and rear spindle bearings. The spindle is made of 60-point carbon crucible steel and is bored No. 3 Morse taper; it is carried in bearings lined with bronze and accurately scraped to fit the spindle. The tailstock spindle is also made of steel and is 1¾ inch in diameter. The apron, including the bearings, is cast in one piece which gives a stiff, strong construction. The design is worked out in such a way that it is impossible to throw in the half nuts when either feed is engaged. The regular equipment includes a compound rest, steadyrest, change-gears, large and small faceplates, a double friction countershaft and the necessary wrenches for making all adjustments.



"Neat" 14-inch Tool-room and Manufacturing Lathe built by National Engineering & Tool Works

The principal dimensions of the machine are as follows: swing over shears, 14⅝ inches; swing over carriage, 7 inches; maximum distance between centers for a 6-foot bed, 36 inches; maximum tailstock travel, 8 inches; diameter of hole through spindle, 1⅜ inch; capacity for thread cutting on standard lathe, 1 to 48 threads per inch; capacity for thread cutting with double compound gears, 1 to 80 threads per inch; width of driving belt, 2½ inches; ratio of back-gears, 3 to 1 and 8 to 1; size of tool used, 1¼ by ⅝ inch; and weight of machine with 6-foot bed, 1400 pounds.

LEHMANN ENGINE LATHE

In general respects the design of this machine follows standard practice. One of the most important features is the arrangement of the quick-change gear mechanism which consists of the familiar cone of gears and a sliding rocker arm with two central gears of different ratios. By dropping this rocker arm one set of changes is obtained, and by raising it the next progressive set of changes is obtained. Forty-eight changes are available for thread cutting and the same applies to the number of feed changes. The machine swings 18¼ inches over the ways and 12 inches over the carriage; work up to 5 feet in length can be held between centers, and the weight of the machine is approximately 3120 pounds.

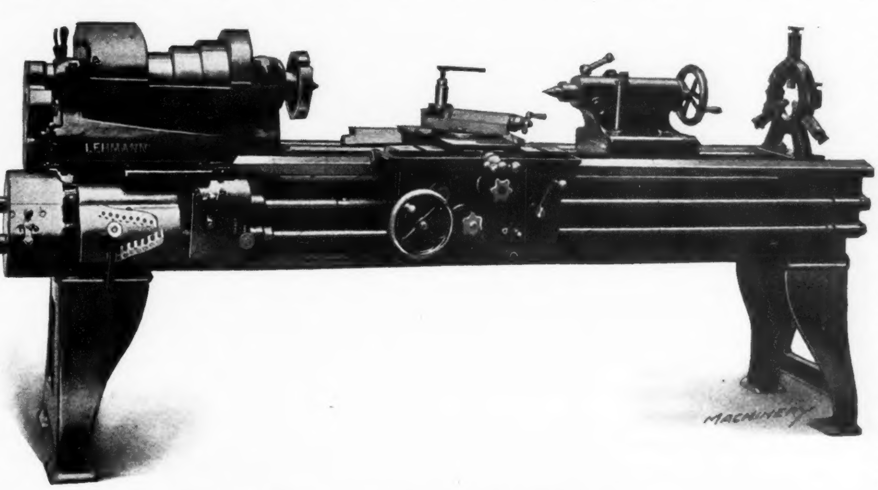


Fig. 1. Lehmann 16-inch Double Back-geared Engine Lathe

The Lehmann Machine Co., 606-612 South Broadway, St. Louis, Mo., has recently placed on the market the 16-inch by 9-foot engine lathe illustrated and described herewith. The bed is braced by cross ribs to give ample rigidity, and the ways are chilled to insure durability and permanence of alignment. All bearings fastened to the bed are doweled in position on planed

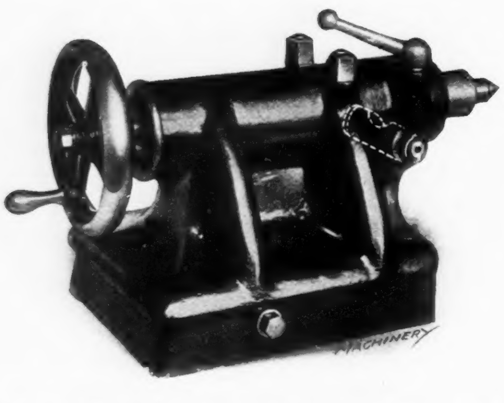


Fig. 2. Tailstock of Lehmann Lathe, showing Improved Spindle Locking Device

bosses. The vees have an included angle of 90 degrees; and the end of the bed is cut away to permit overhanging of the tailstock or placing a steadyrest at the extreme end of the bed. This also facilitates removal of the tailstock or steadyrest. It will be seen that the headstock is cast in such a way that the metal extends straight across from the front to the rear spindle bearing on a line with the spindle, thus tying the bearings together to give plenty of rigidity and serving as a guard to protect the operator from danger of being caught by the belt. The drive is through a three-step cone pulley and double back-gears which give nine changes in geometrical progression.

The spindle is made of high-carbon steel, bored from a solid forging and ground to the required outside diameter. The bearings are lined with phosphor-bronze and positively lubricated; they are securely held in place but may be readily renewed when so required. End thrust is taken by a bearing composed of alternate steel and fiber washers. The tailstock is clamped to the bed by bolts brought up to the top of the barrel. The tailstock spindle is provided with an improved locking device, which consists of a heavy plug shown in outline on the tailstock in Fig. 2, this plug being located in a bearing below the spindle. The plug is made concave to fit the spindle and rests at one end on a shoulder of large diameter, being free to move up against the spindle; the other end extends beyond the back of the tailstock casting and fits into an eyebolt which is suspended from an overhanging lug. The locking handle is located above the lug and is threaded to the eyebolt. A movement of the handle draws the plug up against the bottom of the spindle, and a slight pressure securely locks the spindle in place. The barrel is not slit.

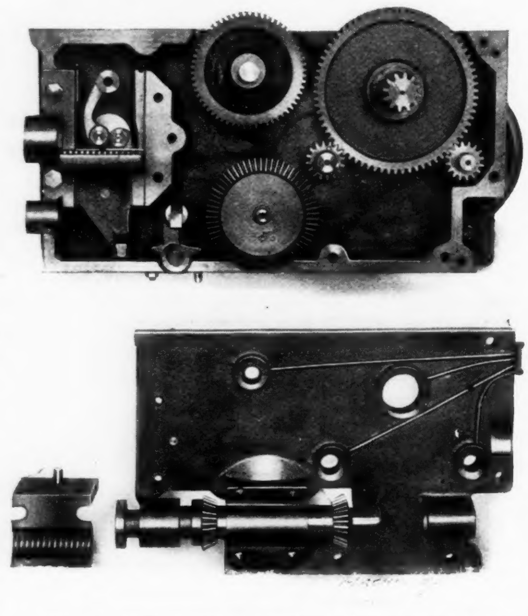


Fig. 3. Arrangement of Gearing in Apron which is of Double Plate Type

The carriage has a wide bridge which insures rigidity under heavy cuts, and is provided with an oil trough that returns the cutting lubricant inside the vees. Shear wipers are fastened to the carriage to keep the vees clean and amply provided with lubricant. The compound rest is of large diameter and heavily built. It is graduated for any angle up to 90 degrees, and is securely held in the bottom of the slide by bolts which are located at a considerable distance from the center and provide ample hold; these bolts are readily accessible at any time. The apron is tongued and grooved to the carriage and provided with a back-plate that gives a double support for all studs and a double bearing for the running shafts. The lead-screw and feed-rod have bearings in the apron to prevent sagging and undue wear on the half nuts and reverse gears. Gears and pinions, except the friction gears, are made of steel and the studs are hardened and ground. A safety device makes it impossible to engage the lead-screw and feed-rod at the same time.

The quick-change mechanism is so designed as to simplify the construction and double the range with the addition of only two gears. A cone of gears with the familiar type of sliding rocker arm is employed, but the rocker has two central gears of different ratios, each with an intermediate gear. By dropping the rocker one set of change-gears is engaged, and by raising the rocker the next progressive set of changes is obtained. This brings the device to a form where all changes commonly used are made by a movement of the rocker arm. For uncommonly fine or coarse threads and feeds, it is only necessary to throw another handle to the right or left. The lathe has a capacity for cutting forty-eight different threads from 2 to 112 per inch, with an equal number of feed changes. The gears are made of steel and the shafts of high-carbon steel, the latter being ground to size after being hardened. The whole quick-change mechanism is a single unit located within a housing that is held on the bed by dowel pins and four screws. It can be easily removed or replaced in a few minutes. The lead-screw is made of high-carbon steel and has a 4-pitch Acme thread. It is provided with a ball thrust bearing which reduces the gear strain; this is an advantage especially when cutting coarse pitch threads and worms. The feed-rod is not running when screw cutting operations are being done; and similarly, the feed-screw is not running when the feed-rod is employed. An adjustable collar on the feed-rod serves as an automatic stop for the carriage feed, and also as a safety. The steadyrest is of improved design, all adjustments and locking being accomplished by star handles. It can be reversed on the bed so that the tool may be run up close from either side.

The principal dimensions of the machine are as follows: swing over shears, 18¼ inches; swing over carriage, 12 inches; maximum capacity for work between centers, 5 feet; travel of tailstock spindle, 7½ inches; diameter of tailstock spindle, 2¼ inches; taper of centers, No. 4 Morse; size of front spindle bearing, 2⅞ by 5 inches; size of rear spindle bearing, 2 1/16 by 4 inches; diameter of hole through spindle, 1 5/16 inch; diameter of spindle nose, 2½ inches; width of driving belt, 3 inches; diameters of cone pulley steps, 6 2/3, 8 1/3 and 10 inches; ratio of first back-gears, 3.33 to 1; ratio of second back-gears, 11 to 1; countershaft speed, 200 to 245 revolutions per minute; spindle speed, 12 to 367 revolutions per minute; number of thread and feed changes, 48; size of tool used, ⅝ by 1¼ inch; size of steadyrest opening, 6 inches diameter; and weight of machine, approximately 3120 pounds.

AUTOMATIC STEEL HARDENING AND TEMPERING MACHINE

The machine which forms the subject of the following description was designed to provide for automatically and uniformly hardening and tempering steel products—especially small, thin pieces. The design provides for passing the work continuously through the machine, and large numbers of parts can be handled rapidly and economically. The operation is under electrical control by means of a device which may be

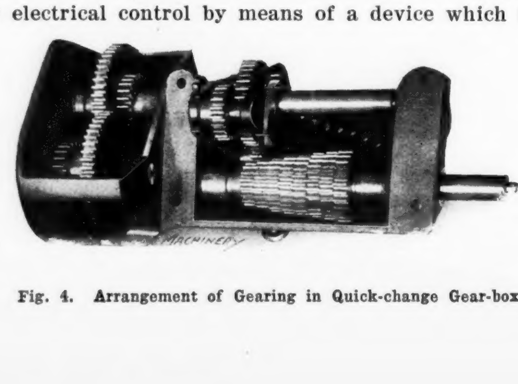
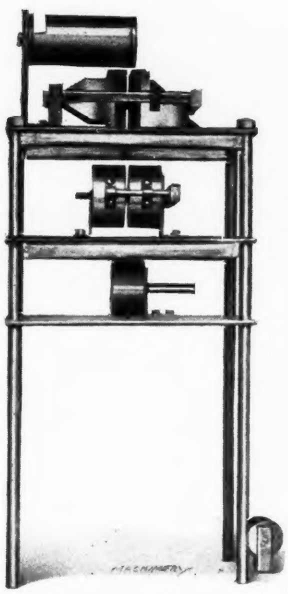


Fig. 4. Arrangement of Gearing in Quick-change Gear-box



Automatic Hardening and Tempering Machine built by American Electric Process Steel Co.

regulated to adjust the rate at which the work is passed through the machine and the duration of its retention in the various heating and cooling mediums. This electrical control is very accurate and may be adjusted to suit the size of pieces which are to be heat-treated and the composition of steel of which they are made.

If so desired, the machine may be enclosed in a muffle; and it is provided with a receptacle to contain the steel articles to be heat-treated, from which the work is automatically removed and permitted to fall between the heating blocks one piece at a time. These blocks are preferably heated by gas, and the work is compressed between them and held until properly heated, after which the blocks are opened and the heated steel product dropped down between the water-jacketed cooling blocks, by which it is caught and held until the steel has been cooled and hardened. Then the cooling blocks are opened and the hot steel product falls down into a tempering chamber in which it is retained until its temperature has been raised to the required degree, when it is released and allowed to fall into a cooling medium, which may be of any form suited to the requirements of the steel being tempered.

In this way steel products may be continuously passed through the machine until the required physical properties have been obtained. The heating and cooling blocks may be so shaped that they receive work of special form; and suitable guides may be provided to guide work of any form from the conveyor to the heating and cooling blocks. A special type of machine is designed to automatically harden or harden and temper large steel articles. The machine shown in the illustration is without electrical and gas connections. This machine possesses several advantages in hardening and tempering steel, among which the following may be mentioned: It is claimed to be impossible to overheat or burn the steel, and there is no danger of underheating the steel so that it will be left too soft.

The degree of hardness obtained is uniform throughout the work, and the method of holding prevents it from being distorted while hardening. Tempering is effected automatically and its results are sure; there is no mechanical contact between the work and parts of the machine, except the contact between the work and the heating and cooling blocks, and the plate in the tempering chamber. Consequently, there is no danger of heat being absorbed from certain parts of the work which would result in a lack of uniformity in its hardness. Efficient means are provided for accurately governing the temperatures of the heating, cooling and tempering mediums, as well as the automatic operation of the machine. This hardening and tempering equipment is a recent product of the American Electric Process Steel Co., 200 Devonshire St., Boston, Mass.

NATIONAL ELECTRIC WELDER

An instance of the way in which the field of electric welding can be extended is represented by a special spot-welding machine that was developed and built by the National Electric Welder Co., Dana Ave., Warren, Ohio, for use in the assembling department of a factory making a specialty of pressed steel forms. This welding machine is wholly automatic in its operation.

Power is delivered through a train of gears from a two-horsepower motor mounted on the base of the machine and running at 1200 revolutions per minute. The work is run through the machine in twelve-foot lengths; and spot-welds on each side are automatically made at the rate of forty per minute. A cam operates a ratchet gear, which, in turn, operates the friction rollers that carry the work through the machine. During the interval between ratchet gear movements, the welding points are brought into contact with the work by means of a second cam.

The welding points are water cooled, the temperature and flow of the water being indicated in the drip cup through which the water passes as it flows from the cooling system to the waste pipe. Despite the seeming complication of parts, the machine is exceedingly simple in operation, so much so, in fact, that it would require actual abuse to impair its efficiency. To provide against abuse, the machine is made unusually sturdy, and liberal provision has been made for carrying emergency overloads.

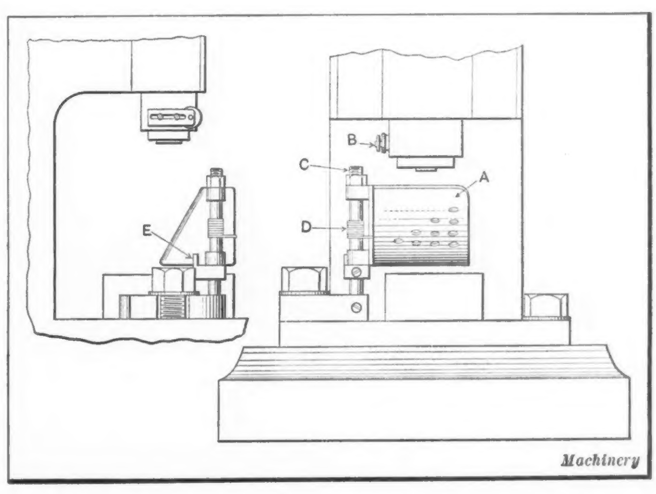
"WARNER" WORK-TABLE

The "Warner" work-table shown in the accompanying illustration is of simple construction and capable of standing up under hard conditions of service. The table is made of cast iron and supported by wrought-iron legs and babbitted joints. This type of table is a great convenience, enabling workmen to keep their tools and work in a convenient position, thus eliminating time lost in looking for misplaced tools or work. The table is particularly adapted for use in tool-rooms, machine shops and garages, and is furnished with two or more trays which are 19 by 25 inches in size. The ordinary table stands 32 inches above the floor and the total weight is 110 pounds. These tables are made both with and without castors. They were originally designed for use in a well-known manufacturing plant where they proved so economical that arrangements were made by J. L. Lucas & Son, Bridgeport, Conn., to manufacture them for the general market.

"Warner" Work-table manufactured by J. L. Lucas & Son

LEGAT PUNCH PRESS SAFEGUARD

The punch press safeguard which forms the subject of the following description was invented by R. C. Legat, and the G. E. Prentice Mfg. Co., New Britain, Conn., is now engaged



Legat Punch Press Guard made by G. E. Prentice Mfg. Co.

in its manufacture. It will be seen that this safeguard consists of a swinging plate or shield *A* which is pivoted at one side. This plate is inclined at an angle, as shown in the side view; carried on the ram of the press is a roller *B* which comes into contact with the inclined guard plate as the ram descends. While the ram is up, the operator can conveniently reach under the inclined guard plate to place work in the die; but when the ram starts to descend, roller *B* comes into contact with the inclined plate causing it to swing about pivot *C*. Should it happen that the operator neglects to remove his hand from the die when he trips the press, the forward movement of guard *A* about its pivot will result in sweeping his hand off the die so that it cannot be caught by the punch.

One end of spring *D* is secured to pivot post *C* and the other end to guard plate *A*. As a result, the spring provides for holding the guard plate back against roller *B*; and as the ram of the press rises, spring *D* returns the guard plate to the starting position. Referring to the side view of the machine equipped with this guard, it will be seen that a stop *E* is provided to limit the backward movement of the guard plate after it is released by the roller on the ram. With a power press equipped in this way, it is practically impossible for an operator to be injured; and its efficiency is attested to by the fact that the Aetna Liability Insurance Co., of Hartford, Conn., has volunteered to rebate $1.75 for every press equipped with a guard of this kind. The guard can be quickly applied to any make of press, without the necessity of changing it in any way.

TUCKER ROD CUTTER AND SHEAR

The accompanying illustrations show a No. 2 shear and rod cutter and a No. 3 shear which are recent additions to the line of machines built by W. M. & C. F. Tucker, Hartford, Conn. In designing these machines, particular attention has been paid to the development of a construction adapted for resisting all strains incident to the operation of machines of this type. All points where pressure is applied have rolling contacts in order to reduce friction to a minimum.

Cutters for the round iron rods are bushings made from cast steel, and they are carefully tempered and held in place by set-screws. Three sets of bushings accompany each machine. Bushings and blades are carried in stock and can be furnished at short notice. The shear blades have a drawing cut, and consequently there is no tendency to crowd the work out of the shear. The blades are made of tool steel and backed up with wrought iron, the design being such that they may be easily removed for sharpening. The movable blade is raised by a steel band which dispenses with the use of a spring. The No. 2 shear and rod cutter is provided with a gage for cutting rods to any desired length. Flat stock may also be cut to any length. The shears operate continuously if so desired.

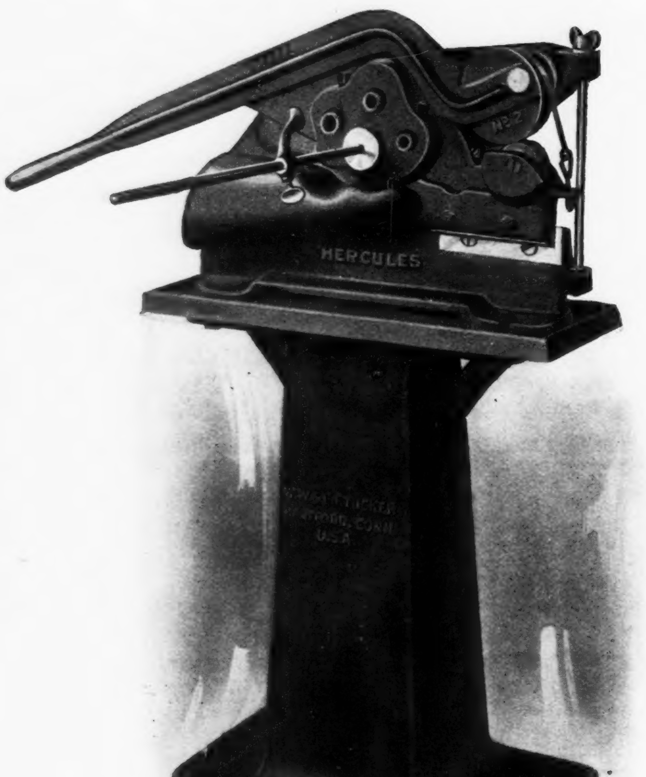


Fig. 1. W. M. & C. F. Tucker No. 2 Shear and Rod Cutter

Fig. 2. W. M. & C. F. Tucker No. 3 Shear

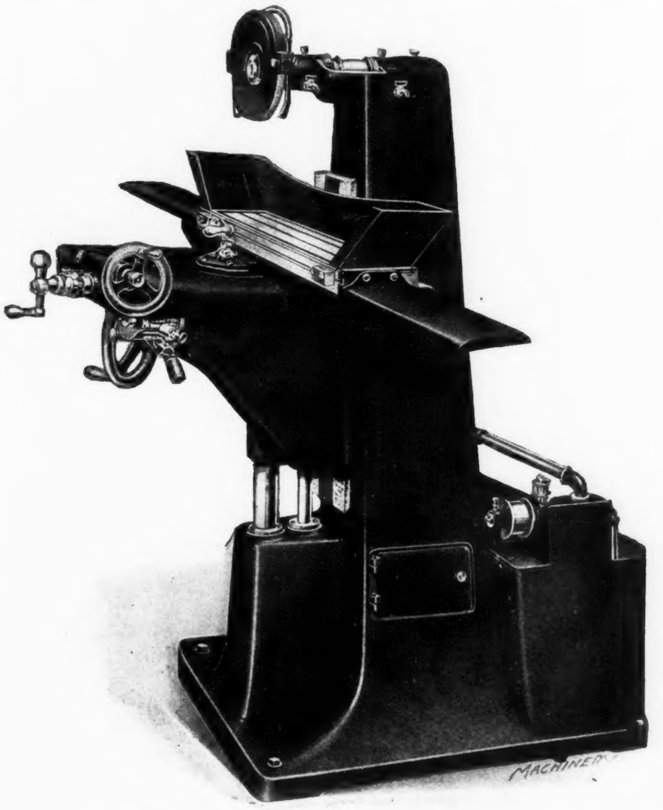
GRAYSON SURFACE GRINDER

The Grayson Tool & Mfg. Co., Indianapolis, Ind., has been engaged for years in the making of dies, tools, gages, etc., and the experience gained in handling this work has been applied in the design of a new surface grinder recently developed by this company with special reference to the requirements of tool-room work. It is generally conceded that the spindle and spindle bearings of a grinder are two of its most important members; and in the new Grayson surface grinder the spindle is made of hardened and ground high-carbon steel which is required to show a hardness of 90 on the scleroscope. In making the spindle, the method of manufacture is conducted in such a way that the threads are chased after the taper part has been hardened and ground; and this eliminates trouble due to distortion of the threads during the hardening operation. The spindle bearings are lined with phosphor-bronze and reamed to fit standard taper plug gages. After running for ten hours, the head is taken apart and the bearings are scraped to master taper plugs. Lubrication of the spindle bearings is provided by four birchwood oilers, which carry a continual supply of oil to the bearings from a reservoir located in the head.

The longitudinal reciprocating movement of the table is 20 inches and the transverse movement 6¼ inches, both of these movements being automatic; and all slides are carefully protected to avoid damage from abrasive dust. The vertical slide

on the column is chilled at the time the casting is made in order to close the grain of the metal. The knee has felt wipers which insure keeping the slides and ways clean. Power is provided by a two-step cone pulley at the end of the wheel-spindle, which drives a hardened steel worm and phosphor-bronze worm-wheel that transmit motion to a vertical shaft which is parallel to the elevating screw. This shaft drives a nest of bevel gears; and the automatic reversal is obtained by two adjustable dogs on the table that operate a hardened steel clutch. The dogs are provided with a spring cushion which makes the reversal almost silent.

The machine is equipped for performing both wet and dry grinding operations. It has been the experience of the Grayson Tool & Mfg. Co. that surface cracks are likely to develop on fine gage work, due to overheating the surface of the steel while the interior remains cool. This difficulty is overcome by grinding the work wet in order to dissipate the heat generated by the grinding operation. On the other hand, when grinding gages and other parts where it is necessary to work to very close limits, it is advisable to grind the work dry.



Surface Grinder made by Grayson Tool & Mfg. Co.

Three spindle speeds are provided to enable the operator to get approximately the same cutting speed when using a 3-inch wheel that he would properly employ when an 8-inch wheel is used on the machine. These are obtained by the use of a three-speed countershaft. There are two rates of table speed.

NEWTON DUPLEX KEYSEATING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., is now building a duplex keyseat milling machine which has a high rate of production due to the double spindle feature that eliminates the time ordinarily required for laying out the work where two keyseats are to be cut in opposite sides of a shaft. The spindles are carried in double taper bearings which are 2 11/16 inches in diameter at the large end and 1 5/16 inch through the driving section; the spindles are fitted with draw-in collets. Automatic feed is provided for the spindle heads, with safety release for use in connection with cottering operations; the maximum feed per stroke of the table is 1/16 inch. Four changes of geared speed are provided for the spindles, without requiring the removal of gears; in addition, there are back-gears on each head which afford additional changes of speed, making the entire speed range from 300 to 1465 revolutions per minute, with a total of eight changes.

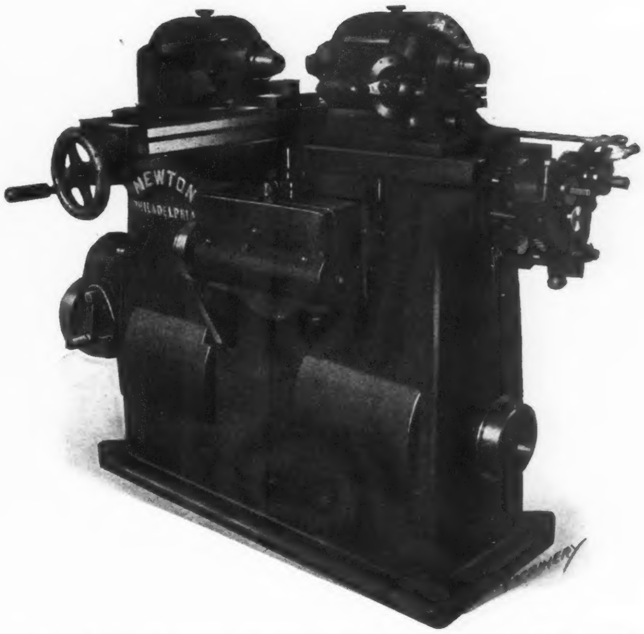


Fig. 1. Duplex Keyseating Machine built by Newton Machine Tool Works

The single driving pulley is 10 inches in diameter by 2¼ inches face width and runs at 735 revolutions per minute. Drums 12 inches in diameter by 8 inches face width are mounted on the driving pulley shaft inside the base, and connection is made by belts to the spindles on which the back-gears are located. High spindle speeds are obtained by open belts, and the slow spindle speeds through the back-gears. The work-table is 44 inches long over all, and has a working surface 38½ by 9 inches. Three changes of feed are available, which may be either continuous for the milling of long splines or automatically reversed for performing cottering operations. The maximum diameter of shafts which can be handled in this machine is 4 inches, and the available feeds and speeds are suitable for cutting keyseats from ⅛ to ¾ inch wide.

The principal dimensions of the Newton duplex keyseating machine are as follows: maximum cross-feed for carriage,

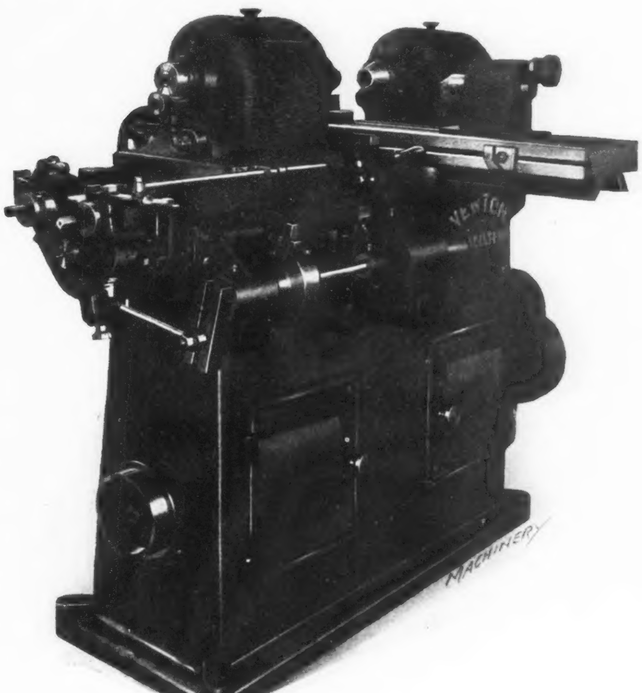
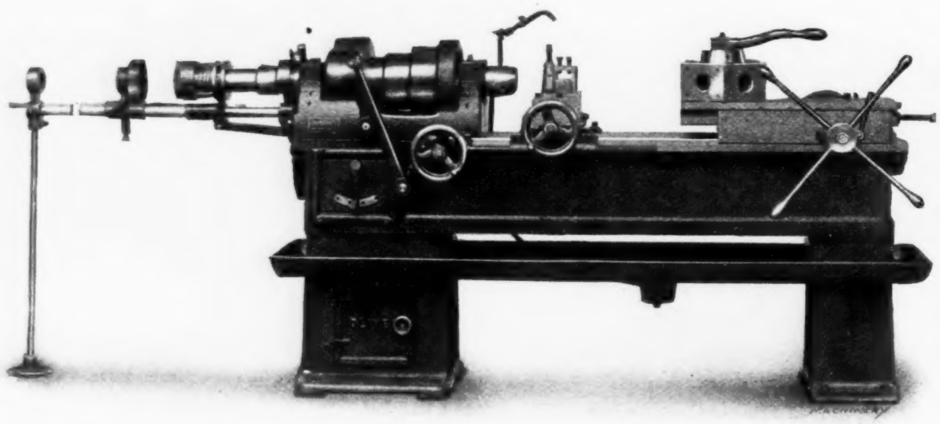


Fig. 2. Opposite Side of Newton Duplex Keyseating Machine shown in Fig. 1

24 inches; height from table to center of spindles, 3½ inches; distance between ends of spindles, from 0 to 10 inches; size of countershaft pulley, 20 inches in diameter by 2¾ inches face width; speed of countershaft, 365 revolutions per minute; and net weight of machine, 3000 pounds. For use in connection with this machine, a fixture has been developed for the Newton slotting machine to provide for cutting both internal keys at one time, thereby insuring an accurate fit of the keys on all sides. In addition to saving time, this dispenses with the necessity of first shaping out one keyseat and then laying out the other keyseat for the operator, which was a slow job at best.



Oliver No. 47-W Screw Machine—Same Machine is equipped as Turret Lathe

OLIVER TURRET LATHE AND SCREW MACHINE

The machine shown in the accompanying illustration is made in two different types by the Oliver Machinery Co., Coldbrook and Clancy Sts., Grand Rapids, Mich. One of these is known as a No. 47-W machine and is equipped with a wire feed attachment for screw machine work. The other is known as No. 47-T and is equipped as a 16-inch turret lathe. General features of both machines are the same and the following description applies to both types.

The No. 47-W type for handling bar stock has a capacity for work up to 2¼ inches in diameter and up to 10 inches in length. The stock is handled by means of an automatic chuck and tool steel spring collet; and the necessary tool equipment may be furnished for handling the various classes of work for which this machine is adapted. Box-tools, boring and facing tools, self-opening threading die-heads, cut-off tools, drills, reamers, etc., may be supplied with the machine in addition to special tools designed for individual classes of work.

The cross-slide is equipped with a 2¼-inch forming tool-holder and a standard No. 4 tool-holder. A handwheel with micrometer dial reading to 0.001 inch controls the longitudinal feed for the cross-slide, and a similar handwheel controls the cross-feed. Multiple stops are furnished with the turret slide acting on each face of the turret.

These are heavy-duty machines, and ample power is provided to enable them to take heavy cuts at high speed. The spindle bearings are lined with babbitt and the spindle is driven by a three-step cone pulley and double back-gears. The spindle bearings are lubricated by means of felt wipers which dip into oil reservoirs in the head. The bed is of a reinforced box-section type and the supporting columns are placed at the extreme ends so that there is no overhang. The standard bed furnished on these machines is 7 feet, 2 inches long, 13 inches deep and 15 inches wide.

The hexagon turret measures 12 inches across the flat and the holes for the tools are 2⅛ inches in diameter. In addition to the tool holes, there are four tapped holes on each face of the turret to provide for securing tool-holders or other special equipment in place. By forcing the turret slide back by means of the handwheel, the locking plunger is automatically released and the head revolves to the next station. The turret is geared to the spindle and may be operated by positive power feed if so desired; to change to hand feed it is merely necessary to trip the power feed lever, dropping the worm out of mesh with the worm-wheel. Gears supplied with the machine provide for obtaining four rates of feed, direct connection being made between the spindle and gear-box by means of a chain drive. A shearing pin protects the gears from damage due to overload.

The cross-slide is 6 inches wide and is adjustable for wear by means of a tapered gib. A large handwheel and coarse cross-feed screw provide for obtaining rapid and powerful cross-feed. The pan is made of pressed steel and is arranged to drain into a cast-iron pot, which is connected with a rotary pump, a copper screen preventing chips from being drawn into the oil or cutting lubricant and thus stopping the pump. The regular equipment consists of a double friction countershaft, cross-slide with toolpost and forming tool-holder, pump, piping, flexible hose, steel chip pan and wrenches.

SLEEPER & HARTLEY SPRING COILER

Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass., has recently added to its line of universal spring coilers a No. 5 machine which has a capacity for winding springs from oil tempered stock ⅝ inch square. It is believed that this is the largest cold spring coiling machine ever built; it occupies a floor space of 6 by 8 feet, and weighs approximately 16,000 pounds. The machine coils the spring and cuts it off automatically, working at a speed of about 50 feet per minute. It is adapted for making either extension or compression springs, and it is possible to feed as much as 100 feet of wire into a single spring.

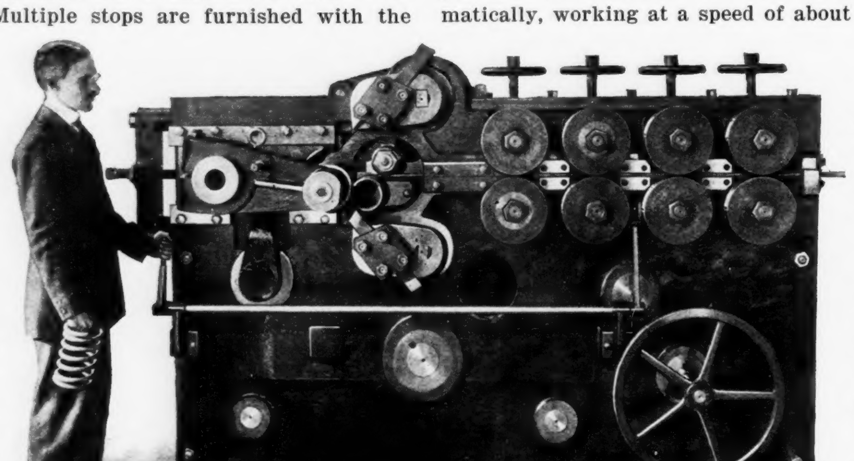


Fig. 1. Sleeper & Hartley No. 5 Universal Spring Coiling Machine for handling Stock up to ⅝ Inch Square—believed to be Largest Spring Coiler ever built

The most interesting feature of the design of this machine is that the spring is not produced by being coiled around an arbor, the coiling being done by forcing the wire forward through feed rolls until it strikes a coiling point or "deflector." Provision is made for feeding a predetermined

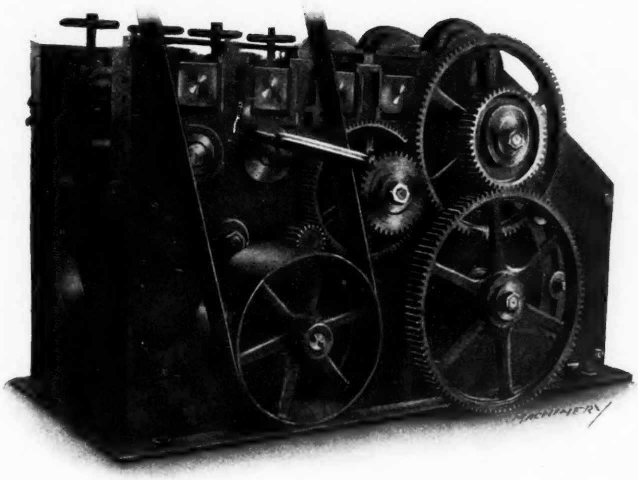


Fig. 2. Opposite Side of Sleeper & Hartley No. 5 Spring Coiler shown in Fig. 1

amount of wire into each spring. The operation is automatic, the machine coiling and cutting alternately; the coiling mechanism is stopped while the spring is being cut off, and *vice versa*. The only function of the arbor is to provide a cutting edge against which the exterior cutter may carry the wire for the purpose of shearing it off after the winding of the spring has been completed. Adjustment is provided to govern the amount of wire fed into any one spring, and also to regulate the diameter and pitch of the spring, as well as its contour. Changes in either of these features of the work may be instantly made by means of adjustments on the machine.

Variations in the rate of feed are obtained by means of change-gears, and the feed may be closely regulated by an

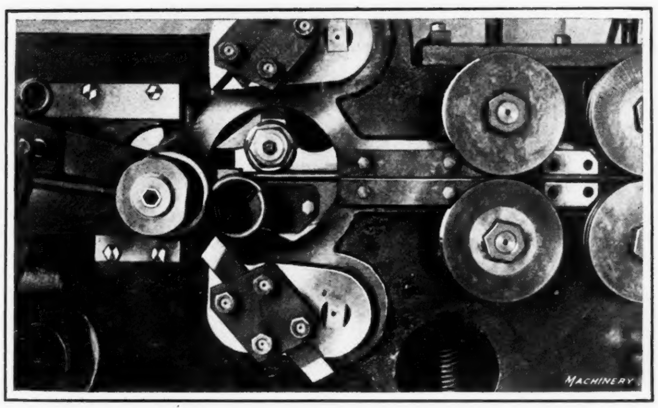


Fig. 3. Close View of Coiling Mechanism on Sleeper & Hartley No. 5 Spring Coiler

adjustable cam which controls an automatic clutch. The diameter and contour forming mechanism is also controlled by means of a cam, a single cam only being needed to produce any kind of tapered spring; and a pair of cams provides for producing every conceivable variety of barrel shaped springs. The pitch is automatically controlled, and springs may be either produced with an open spiral or the end coils may be "flatted" or "laid close" to as great an extent as desired. The machine may be changed over from one type of spring to another in from ½ to ¾ hour. It will be obvious that next to the ability to form springs of any desired contour, the greatest advantage of this machine is the ability to control the pitch and to be able to produce springs with squared ends, thereby eliminating the costly method of squaring the ends of the springs by a subsequent heating and pressing operation.

CODD CHAIN FURNACE DOOR

Anyone who has fired a furnace knows the discomfort experienced when it is necessary to open the door of the firebox to stoke the fire or shovel in more coal. But the discomfort to the fireman is not the only bad feature of this condition. Very little thought is required to show that as soon as the furnace door is opened, cold air rushes in and reduces the temperature of the fire; and this is indicated by a falling off of the indication of the pressure gage when the door of a boiler furnace is left open for any considerable length of time. Also, this reduction of temperature causes the heated furnace lining and other parts to shrink, the shrinkage being frequently followed by cracking of the brickwork. In conducting various metallurgical processes such as the heat-treatment of steel, a reduction of temperature due to heat lost through opening the furnace door is liable to result in a lack of uniformity of the product.

With the view of overcoming trouble from this source, the E. J. Codd Co., 700-708 S. Caroline St., Baltimore, Md., has developed the "Wiegand" chain screen door for furnaces, which is shown in the accompanying illustrations. It will be seen that this consists of a number of small chains which

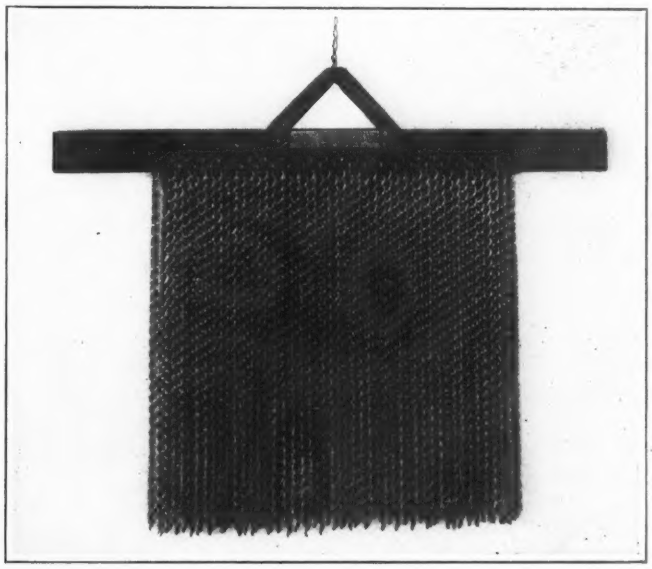


Fig. 1. "Wiegand" Chain Screen Door for Furnaces made by E. J. Codd Co.

hang loosely in front of the furnace door. These chains keep the hot air in and the cold air out of the furnace, but enable the fireman to shovel in coal or stoke the fire without personal discomfort and without lowering the temperature of the fire to a serious extent.

For the purpose of establishing the efficiency of this form of door, the following experiment was conducted. A thermometer was fixed on a standard in the fire room at a point opposite the furnace door and 10 inches in front of it. This position was selected as being one often taken by the fireman in stoking or cleaning the fire. When the ordinary fire door

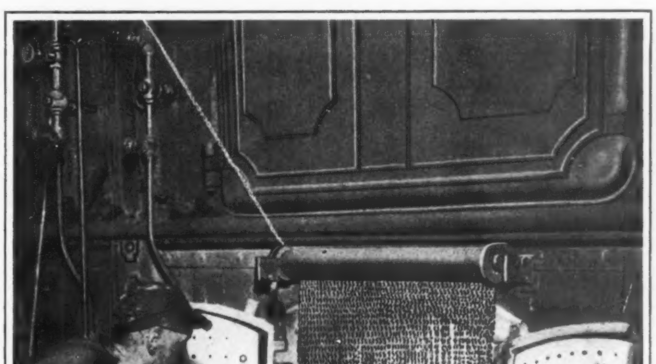


Fig. 2. Application of "Wiegand" Chain Screen Door on Boiler Furnace

was thrown open and the incandescent fire bed exposed, as is the case wherever the furnace is fired or cleaned, this thermometer rose until a temperature of 400 degrees F. was indicated. On covering the furnace door with the "Wiegand" chain screen door, the temperature at once dropped 265 degrees until a constant temperature of 135 degrees F. was indicated; and under this condition the bare hand could be held anywhere in front of the screened opening without experiencing discomfort. This incates that a great quantity of heat lost by radiation and convection through the ordinary uncovered furnace opening may be saved by the employment of a chain door of this type. The heat intercepted by the chain composing the screen is returned to the furnace instead of being wasted, as the air which actually enters the furnace through the chain door takes up the heat that has been absorbed by the chain and carries it back into the combustion chamber. This chain door forms a flexible penetrable transparent sheet which does not interfere with inspection of the interior of the furnace.

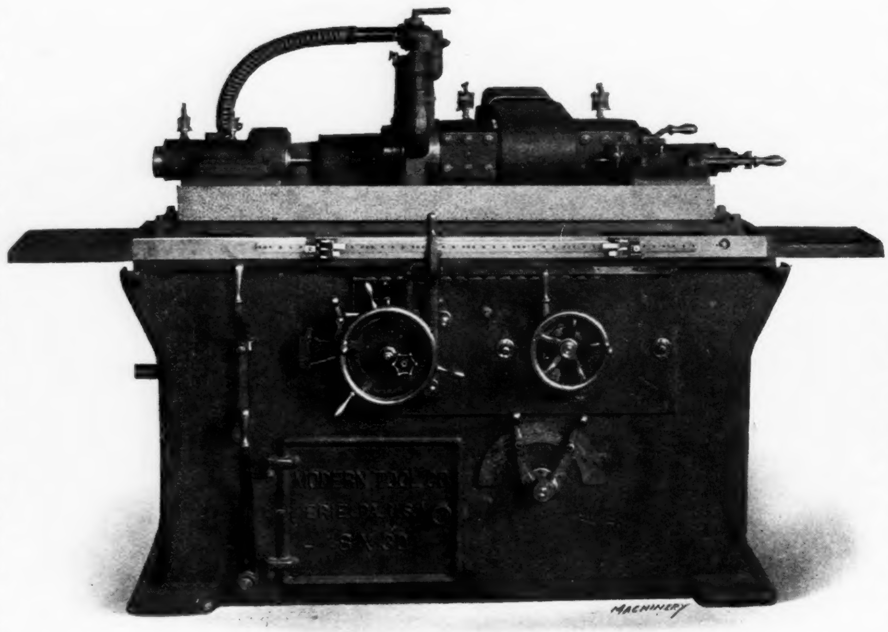


Fig. 1. Front View of Modern 8- by 30-inch Self-contained Grinder, with Heavy Type of Drive

MODERN SELF-CONTAINED GRINDING MACHINES

Noticeable features of these machines are the comparative simplicity of the mechanism, location of all control levers within easy reach of the operator, and a compact design which economizes floor space as far as possible. The machines are made in 8- by 18-inch and 8- by 30-inch sizes, but the design of both is essentially the same with the exception of the fact that a "heavy-duty" type of drive may be furnished when the larger machine is to be used for exceptionally heavy work. These are manufacturing machines, and are adapted for grinding straight or taper cylindrical work in large quantities.

The Modern Tool Co., 2nd and State Sts., Erie, Pa., has added to its line of self-contained grinding machines the 8- by 18-inch and 8- by 30-inch grinders shown in the accompanying illustrations. Fig. 1 shows a front view of the 8- by 30-inch machine, and Fig. 5 shows a front view of the 8- by 18-inch grinder. With the exception of the center distances and details of the wheel drive, the two machines are similar, and the detailed description which follows is applicable to both. Economy of floor space, ease of operation, and comparative simplicity of the mechanism are distinguishing features of these machines. All operating levers are concentrated at the front, and nothing extends above the wheel stand, all mechanism being contained within the machine.

These are essentially manufacturing grinders, and they are adapted for finishing straight or taper cylindrical work in quantities. All parts are accessible, so that they can be properly cared for without unnecessary expenditure of time, which is a factor in keeping up the rate of production. The bed is a one-piece casting, rigidly braced to insure stability.

It is of compact design and the units are so located as to be easily accessible. Vee and flat guides are used on the sliding table, swivel table and under the wheel stand, insuring perfect alignment of all parts. The base rests upon three points, preventing cross strain, preserving alignment and providing for irregularities in floor level.

These machines are provided with an exceptionally powerful drive, liberally proportioned spindles and bearings of ample size. The standard wheel-spindle is $2\frac{1}{4}$ inches in diameter; it runs in phosphor-bronze bearings $6\frac{1}{4}$ inches long, and is driven by a belt 4 inches wide. However, as there are instances where the machines will be required for exceptionally heavy service, they can be furnished with a wheel-spindle $3\frac{1}{4}$ inches in diameter, running in phosphor-bronze bearings $8\frac{1}{4}$ inches long and driven by a belt 5 inches wide, a corresponding increase having been made in the wheel stand pile. Fig. 1 shows the 8- by 30-inch machine equipped with this

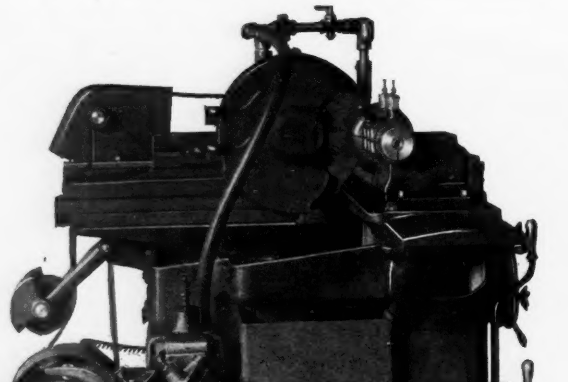


Fig. 2. Modern 8- by 18-inch Grinder, showing Main Drive, Wheel Base and Pump

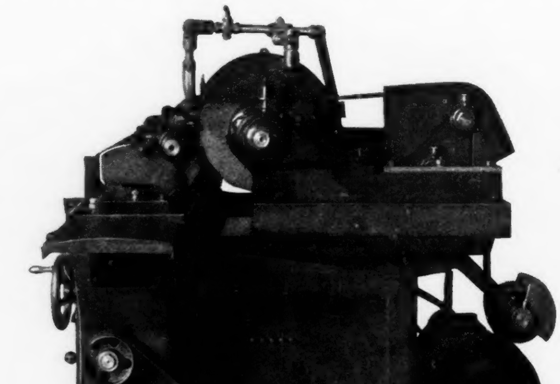


Fig. 3. Right-hand End of 8- by 18-inch Grinder, showing Table Drive, Gear-box and Main Drive

heavy drive. The bearings are in each instance provided with sight-feed oilers, which deliver the proper supply of oil to the boxes at all times.

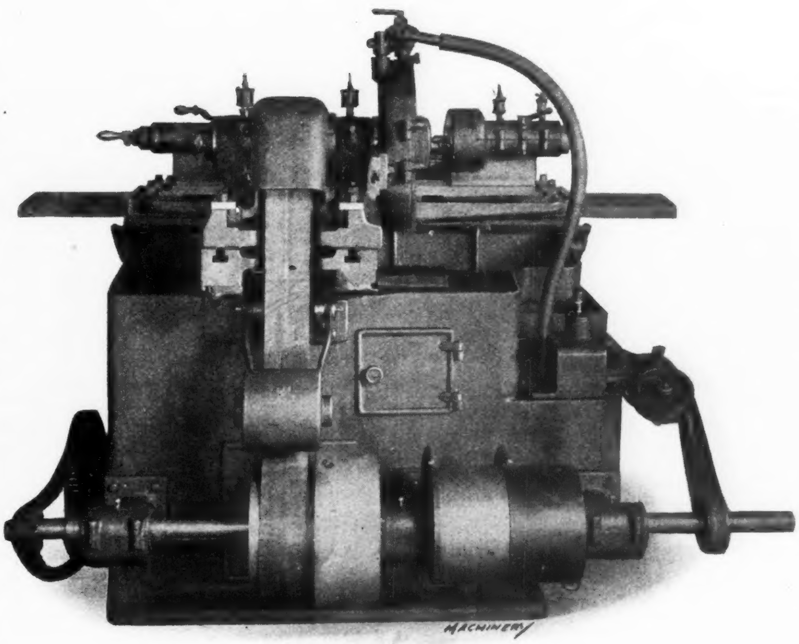


Fig. 4. Rear View of Modern 8-by 18-inch Self-contained Grinder, showing Arrangement of Main Driving Shaft

The wheel stand pile is bolted to the bed of the machine and is of generous proportions, as may be seen by referring to Figs. 2 and 3. The wheel stand slides on vee and flat ways, and is held in place by gravity; but it is provided with a safety gib to guard against lifting under abnormal conditions. The wheel center is of large diameter, has a long bearing on the spindle, and will take any of the recognized standard grinding wheels. The wheels used on the standard machines are 16 inches in diameter and up to 3 inches face width. The wheels used on the heavy drive are 18 inches in diameter and up to 4 inches face width. The table slide is unusually heavy and powerfully ribbed to resist torsional strains. The swivel table has a generously proportioned bearing on the table slide and pivots on a large central stud. The table provides for grinding tapers and is graduated to read tapers in inches per foot.

The table drive is of a very simple type, eliminating the table transmission formerly employed. It consists of a single unit contained in the bed of the machine, which is a combination of table drive and transmission. All steel spur gears are used for the reversing mechanism; and the power table traverse is controlled by a lever located immediately to the left of the table handwheel, which provides for starting or stopping the table at any point in its stroke. When the table is under power the handwheel is automatically disengaged, and when the power drive is released the handwheel is automatically engaged for traversing the table by hand. There are four table feeds, derived from a gear-box which is controlled by a lever located at the right and immediately below the table handwheel.

The automatic cross-feed is positive in its action and the design has been simplified without losing any of its important features. It can be set for a reduction of any amount from 0.0005 to 0.005 inch at either or both ends of the table reverse. This latter feature is especially advantageous when grinding against a shoulder. The feed is automatically thrown out when the work is ground to size, and a positive stop is provided for use when feeding by hand. The cross-feed handwheel is graduated to read to 0.0005 inch and is always in plain view of the operator. Adjustment of the cross-feed is made by moving a lever to give the amount of feed desired, as indicated on a graduated dial plate, and may be instantly changed to give any feed while the machine is in operation.

The headstock is of entirely new design, being driven from a shaft under the sliding table. This shaft is driven by a pulley carried in a bracket on the bed, to which power is taken from the gear-box. The shaft under the table is splined through its full length for the ball driver which is contained in the pulley mounted on the bed. The balls not only drive the shaft but also eliminate friction in the traversing movement. The headstock is driven from this shaft by a belt which runs over an idler pulley and gives a large surface of contact to the headstock pulley, thus insuring plenty of power. The belt drive gives an absolutely smooth movement to the work and eliminates any possible chance for chatter. The headstock is fitted to the swivel table by means of vee and flat ways, and is held rigidly in position by clamp bolts. The headstock spindle is hardened and ground, and runs in bronze bearings which are adjustable for wear and lubricated by means of sight-feed oilers.

A feature of the headstock design is the combination of live and dead centers. The spindle is carried in bearings in the headstock base, in which it revolves for live-center work, the faceplate being clamped to the spindle and the spindle revolving in the headstock bearings. To change for dead-center work, it is only necessary to loosen a screw which clamps the faceplate to the spindle, and tighten the clamp on the headstock which holds the spindle firmly in the headstock base. The dead-center pulley is then free to revolve upon its bearing for regular dead-center work. The tailstock is fitted to the swivel table and preserves its alignment in the same manner as the headstock. The tailstock spindle is held in any position by a spring, or it may be set positively against the work and locked in place. The work centers on the headstock and tailstock are located directly over and between the guides of the table, a form of construction which is claimed to eliminate the weight and strain necessarily present where the work centers are placed outside and overhang their bearings.

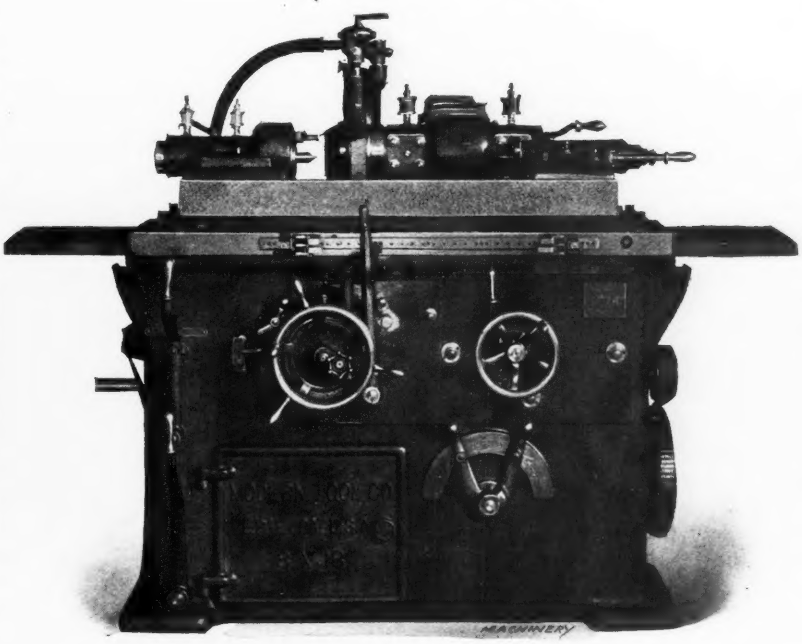


Fig. 5. Front View of Modern 8- by 18-inch Self-contained Grinder, showing Centralized Control

The wheel truing device is mounted on the tailstock and is adjustable to suit wheels of all diameters which come within the range of the machine, so that the wheels can be trued without removing the work from the centers.

Steadyrests for these machines are universal in all their movements. They are equipped with positive stops for grinding duplicate parts, have a wide range and are capable of delicate adjustment. The pump is of the fan type; it revolves in a horizontal plane and is kept immersed so that it is constantly primed and no packing is required. The water tank is of ample size and provided with settling pans which are easily accessible for cleaning.

The Modern 8- by 18-inch and 8- by 30-inch self-contained grinding machines have eight work speeds from 26 to 390 revolutions per minute, and four table feeds from 22 to 104 inches per minute. The feeds and speeds are entirely independent of each other, and are suitable for the various classes of work which come within the range of these machines. All work speeds and table feeds are controlled by levers on the front of the machine, and are derived from a separate unit gear-box which, in addition to occupying a very small space, is so located as to be easily and readily inspected. The gears are made of specially treated steel and are in mesh at all times,

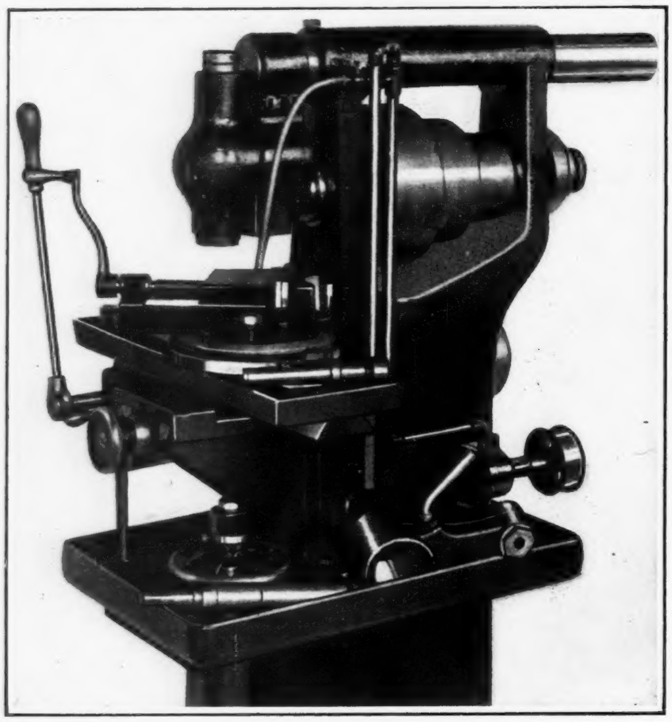


Fig. 1. Bickford Plain Milling Machine equipped with Vertical Attachment and Swivel Vise

their engagement with the shaft being effected by means of the Modern Tool Co.'s patent ball drive clutch which enables a quick and safe change to be made instantly while the machine is operating at any speed. The gear-box, while smaller in size, is the same as that used on the larger self-contained grinding machines of this company's manufacture.

These self-contained grinding machines have single constant-speed drive, which reduces the cost when equipping the machines with motors. The main drive is located at the rear of the machine and runs at constant speed, power being supplied from the lineshaft by a single belt, or by a motor connection.

BICKFORD VERTICAL MILLING ATTACHMENT AND MILLING MACHINE VISE

The Bickford Machine Co., Greenfield, Mass., is now manufacturing a vertical milling attachment which is shown in Fig. 1 set up on a machine ready for use. This attachment is of simple design and the illustration makes it so clear that only a brief description is necessary. It will be seen that the attachment is hung from the over-arm of the milling machine and that power is taken from the milling machine spindle and transmitted through bevel gearing in the head to the vertical spindle of the attachment.

Fig. 2 shows a close view of the new Bickford milling machine vise which is illustrated in position on the machine

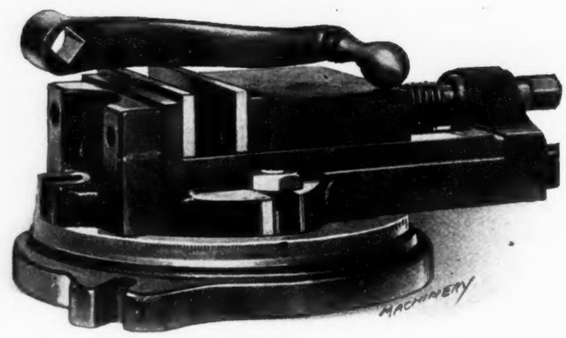


Fig. 2. Close View of Bickford Swivel Base Vise shown on Machine in Fig. 1

in Fig. 1. It will be apparent that this may be used as a swiveling vise, as shown in the illustrations, or removed from the swivel base and bolted directly to the table of the milling machine when it is desired to use a plain vise. The swivel base is convenient when milling operations are to be performed on which accurate indexing must be done between successive cuts. Two sets of lugs on the vise provide for bolting it with the jaws parallel or at right angles to the spindle, when the vise is used without the swivel base.

T. P. WALLS EMERY BAND GRINDER

In the July, 1915, number of MACHINERY, mention was made of two styles of emery band grinders built by the T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City. These were bench machines intended for use in finishing parts that require a "straight grain" finish. When such a finish is required, the use of a power-driven emery band is the means of saving a great deal of labor and materially reducing manufacturing costs. These machines are made in two types, one of which is simply provided with an emery band, while the other is furnished with a disk wheel in addition to the band.

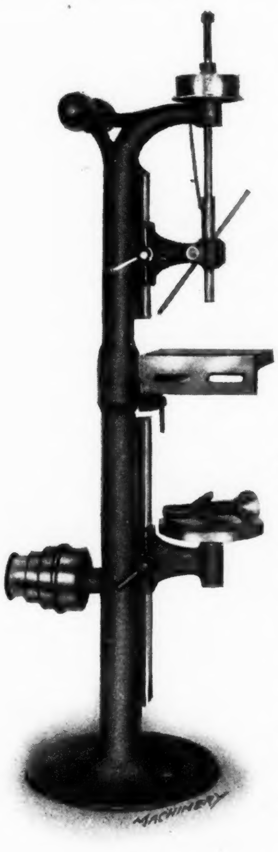
Recently the same company has introduced what are known as the "Simplex-B" and "Duplex-B" emery band grinders. As in the case of the bench machines, the "Duplex-B" is a combination emery band and disk grinder, while the "Simplex-B" machine is simply provided with the emery band. Instead of being intended for use on a bench, however, both of these machines are provided with substantial stands, making them

T. P. Walls "Simplex-B" Emery Band Grinder

self-contained units. On each machine the abrasive band is 8 inches wide by 61 inches long, and on the "Duplex-B" machine the disk wheel is 15 inches in diameter. The weight of the "Simplex-B" machine is 350 pounds and the weight of the "Duplex-B" machine is 405 pounds.

JOHNSON SENSITIVE DRILL

The Johnson Machine Tool Co., Gouverneur, N. Y., is now building a sensitive drill press suitable for performing accurate drilling operations at high speed. To relieve the spindle of belt strain, the pulley is supported on an independent bearing which takes the entire pull of the belt. Lever feed is provided, which is operated through a rack and pinion; and the quill and spindle are counterbalanced by a weight inside the column of the machine. The round table is vertically adjustable on the column, and it can be easily removed to enable a cup or crotch center to be substituted in the round table bracket. The square table has a slotted apron and can be swung around the column or tipped to any required angle. A taper pin provides for locking this table at an exact right angle to the drill spindle. The spindle is made of electrically heat-treated open-hearth steel; and it is equipped with an anti-friction thrust bearing having an adjustable collar. The regular equipment includes the square and round tables, crotch and cup centers, and a countershaft.



Sensitive Drill built by Johnson Machine Tool Co.

The principal dimensions of this drill press are as follows: capacity for drilling holes up to 9/16 inch in diameter; width of driving belt, 1¾ inch; total height with spindle up, 7 feet; height of column, 70 inches; diameter of base, 20 inches; hole in spindle bored No. 1 Morse taper; maximum distance from spindle to square table, 12 inches; maximum distance from spindle to round table, 42 inches; distance from center of spindle to column at square table, 7⅜ inches; vertical adjustment of spindle head, 10 inches; vertical travel of spindle, 3 inches; vertical adjustment of round table, 26 inches; countershaft speed, 450 revolutions per minute; and net weight of machine, 325 pounds.

LANDAU TURRET HEAD DRILL

In the May, 1914, number of MACHINERY, a description was published of a small turret head drilling machine built by J. N. Landau, 239 W. 68th St., New York City. Those who read this description will recall that the turret head of the machine provides for indexing each of the tools into the working position. As each spindle is brought into the working position it is engaged by a clutch on the machine spindle to drive the tool.

The machine shown in the accompanying illustration is of essentially the same design as the preceding type of Landau multiple turret head drill with the following important exceptions: Depth stops are provided for each of the spindles in the turret head so that the depth to which the tools work may be accurately regulated; and the turret head is provided with one tapping spindle, so that it is possible to handle the work of tapping holes in which a thread is required. The forward drive of the tapping spindle is effected in the same way as that of the other spindles of the turret head; but gearing is provided on the tapping spindle, and when the hole has been tapped to the required depth, a clutch is automatically thrown to engage the reverse gearing for backing out the tap.

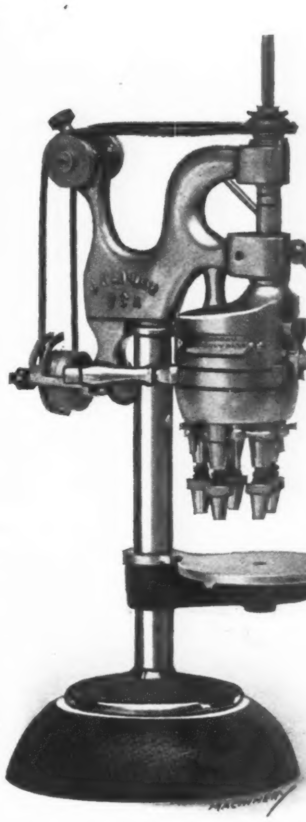


Fig. 1. Landau Turret Head Drill with Positive Depth Stops and Tapping Spindle

It will be evident that there is a great variety of instrument work and similar classes of service on which a turret head machine of this type could be used to advantage. In addition to use on the Landau machine, the turret head may be used on other types of drilling machines; and the same type of turret head may be used in the tailstock of a lathe. In all cases the method of operating the turret is the same.

Fig. 2 shows the arrangement of the gearing for backing out the tap after it has finished its work. As in the case of all other spindles in the turret head, power is transmitted from the main driving shaft to clutch *A* and then through gears *B*, *C*, *D*, and *E*, by which a suitable reduction of speed is obtained. Gear *E* is locked to the driving shaft *F* by engagement with locking pin *G*. The slowest speed for tapping is 150 revolutions per minute. After the tap has completed its work, clutch *A* comes into contact with an adjustable stop-bar *H* which is set according to the depth of hole to be tapped, with the result that the clutch on gear *E* is disengaged from pin *G* and reversing clutch *I* is engaged. The drive is now through gears *B* and *C* and thence through gears *J*, *K*, and *L*, the ratios being such that the tap is backed out at a speed of 250 revolutions per minute. Gears *C* and *D* are always in mesh with gears *B* and *E*, although gear *E* is only rotated when the forward driving clutch engages pin *G*.

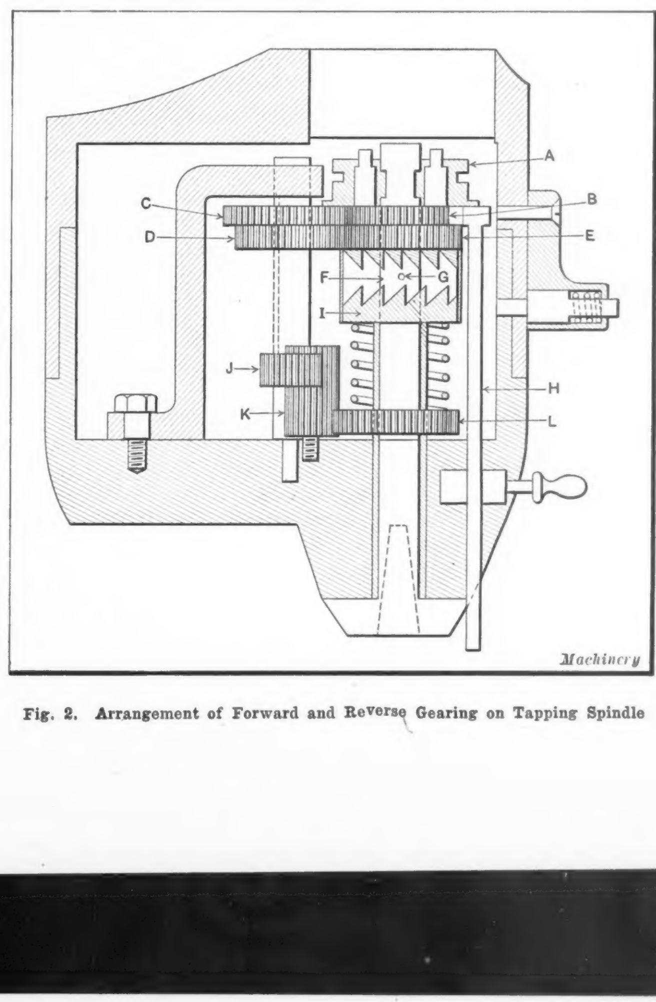


Fig. 2. Arrangement of Forward and Reverse Gearing on Tapping Spindle

OLIVER HEAVY-DUTY SCREW MACHINE

This is a heavy-duty machine that may be equipped for either screw machine or turret lathe work. The range of work for which it is adapted runs from heavy chucking operations on forgings or castings to high-speed work on brass bar stock. Both hand and power feeds are available, and the six available rates of power feed range from 0.006 to 0.052 inch per revolution for both the cross-slide and turret slide, the feeds being independent of each other. A single lever controls both feeds, and pointers running over a double dial indicate the rate of feed being employed on the cross-slide and turret slide.

The No. 27 heavy-duty screw machine or turret lathe now being built by the Oliver Machinery Co., Coldbrook and Clancy Sts., Grand Rapids, Mich., has been designed to operate under high speeds and heavy cuts. The control of all movements is concentrated at the front of the machine, making its manipulation simple and rapid. The range of work for which the machine is adapted extends from heavy chucking operations on forgings or castings to high-speed work on brass bar stock. The headstock is of the friction back-geared type, and is controlled by a lever at the left-hand side of the operating position; the head is cast integral with the bed and extended straight across on a level with the spindle bearing, thus forming an exceptionally rigid construction. The friction back-gears are entirely enclosed and the cover may be instantly removed for the purpose of inspection or making adjustment. Adjustment of the friction ring is effected by means of a simple screw mechanism which regulates the pressure on the ring. Both front and rear spindle bearings are lubricated by felt wipers which extend down into oil reservoirs of liberal capacity.

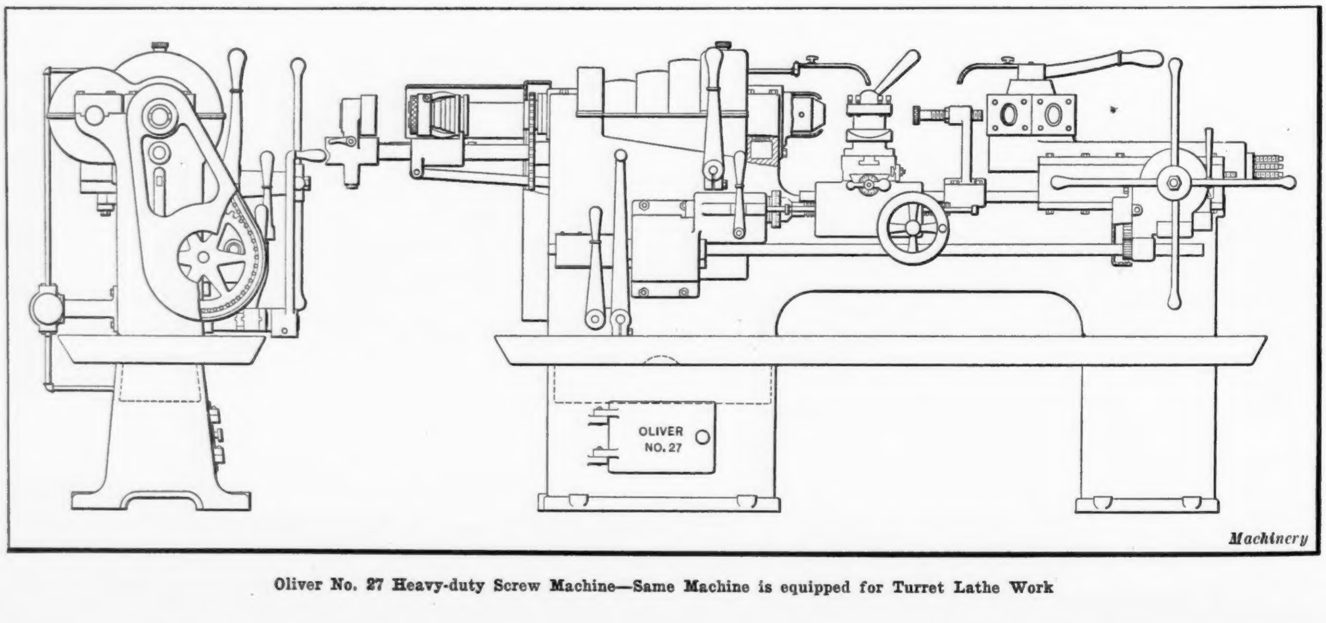
When the cross-slide is operated by power, six rates of feed are available ranging from 0.006 to 0.052 inch per revolution; and the same rates of feed are available for the turret slide, but the feeds are entirely independent of each other, any combination of the two sets of feed being quickly obtainable. The power cross-feed operates the carriage longitudinally in either direction, or it can operate the cross-slide forward or back by clamping the carriage to the bed and throwing in the cross-slide feed. Automatic knock-outs are furnished on both the cross-slide and carriage to provide for disengaging the power feed; these operate in both directions. A small lever controls the direction of feed, and micrometer dials are placed on both the longitudinal and cross-feed screws to facilitate handling accurate shoulder work or facing; these dials reading to 0.001 inch.

The cross-slide is provided with two parallel T-slots at the rear and one at right angles in the front, an arrangement which permits of the use of a great variety of tools for cross-slide work. The regular equipment consists of an open-side cut-off tool at the rear and a four-sided turret tool-holder at the front. When so desired, the power feed may be omitted and hand-operated longitudinal feed substituted in its place. The design of the cross-slide is the same in both cases, but the turret toolpost is replaced by a single tool-holder and the power gearing is omitted. The handwheel is provided with a dial reading to 0.001 inch, for accurate turning operations; and the cross-slide dial is the same as in cases where power feed is employed. Longitudinal travel is the same, no matter whether hand or power feed is used. When so desired, a lever cross-slide arrangement can be substituted in place of the screw feed mechanism.

The turret is made of cast iron and is bored and counterbored in position on the lathe to insure perfect alignment. The turret stud is $2\frac{1}{2}$ inches in diameter and is drilled to allow stock up to the full capacity of the machine to pass entirely through the turret. The locking plunger is made of hardened tool steel and is accurately ground to size; it enters a hardened tool-steel bushing and slides in a hardened and ground sleeve. The turret slide may be furnished with either power or hand feed. When power feed is employed the rates available are 0.006, 0.010, 0.015, 0.025, 0.040, and 0.052 inch per revolution of the spindle. The control of these feeds is obtained by a lever located at the left of the gear-box, and a dial plate and pointer show which feed is engaged. The mechanism is of the sliding key type, enabling selection of feeds to be made while the machine is either running or at rest. The turret slide is secured in place by means of taper gibs at each side and by hold-down gibs, all of which are accurately scraped to a true bearing. Multiple stops provide for disengaging the power feed at each face of the turret, and form a positive stop by a slight forward movement of the hand-lever. The multiple stop mechanism is directly geared to the turret head and cannot get out of adjustment. The power feed mechanism consists of a steel rack and gears, working in conjunction with a drop-worm which is either released or thrown into mesh by opposite movements of the same lever that is conveniently located for the operator.

The turret slide is adjustable forward or backward on the shears of the bed, to the limit of length of the bed; and it is clamped externally by means of rectangular gibs acting outside of the shears. Adjustment for wear is provided for by means of a taper gib under the ways, which is adjusted by two screws of fine pitch. This combination of taper gibs for the slide and ways gives complete control of adjustment for any wear that may develop. In addition, the exceptionally large bearing surfaces of the slide and ways afford long life and great accuracy.

The change-gear system consists of steel and cast-iron gears running in oil; and it is of the sliding key type. Six rates of feed are provided for the turret and the same number for the cross-slide, and, as previously mentioned, these feeds are independent of each other. A single lever controls both feed changes, and the rate of feed being obtained by the turret or cross-slide is indicated by a dial and two pointers. The gear-



Oliver No. 27 Heavy-duty Screw Machine—Same Machine is equipped for Turret Lathe Work

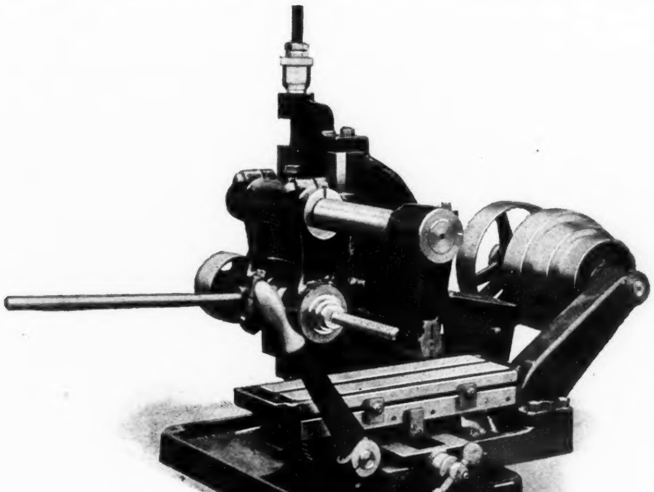
box is located underneath the headstock and is completely enclosed so that adequate protection is provided against damage from chips or dirt. All bearings are furnished with a copious supply of lubricant so that efficient operation is assured at all times. An independent and adjustable stock stop clamped to the bed forms a regular part of the equipment of the universal turret lathe. This stop allows the entire six spaces of the turret to be used for cutting tools.

The wire feed lever is of ample length to afford plenty of leverage for the feed mechanism. The pan is made of sheet steel and while it is very stiff it is also light; the pan extends entirely around the machine and is so placed that provision is made for cleaning off chips from underneath the bed. The reservoir for oil or cutting compound is contained in the leg at the head end and has a capacity for holding several gallons. A large hand-hold plate at the rear of the lathe may easily be removed for cleaning the mechanism, and to clean out the pan it is not necessary to remove the pump or piping. The pump is of the reversible type and supplies a steady flow of lubricant to each of two delivery tubes, one of which supplies lubricant to the turret tools and the other to the cross-slide tools. The pump is driven directly from the countershaft and is independent of the speed of the spindle or the rate of feed being employed.

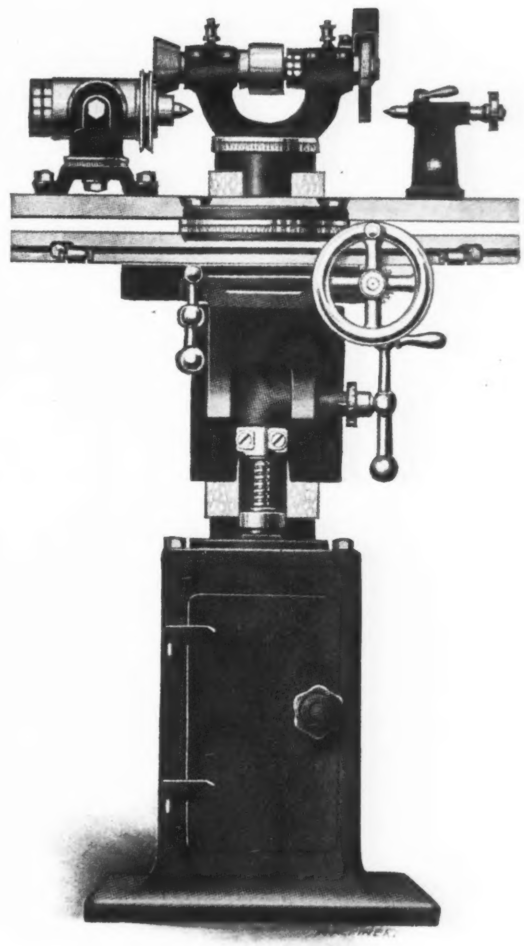
MORRIS BENCH MILLER

The Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio, is now building the No. 0 bench miller of the adjustable head type illustrated and described herewith. The machine is also furnished with a column to provide a floor type of machine. The head is moved up and down on the column by means of a lever-operated rack and segment; the lever can be placed in two positions to suit the convenience of the operator, and a micrometer depth gage is provided to facilitate the making of accurate settings. The head is counterbalanced by a weight that is made adjustable for use with different sizes of cutters and arbors, making it possible to counterbalance the head very accurately. The spindle runs in bronze bearings, the front bearing being tapered and provided with means of compensating for wear. The back shaft also runs in bronze-lined bearings and all bearings are lubricated by a capillary oiling system.

Six changes of speed are obtained through the three-step cone pulley by reversing the pulleys on the ends of the spindle and back-shaft. The table traverse is obtained by a lever-operated rack and pinion; and the saddle is fed in and out by means of a square threaded screw which has a micrometer attachment. The principal dimensions of the machine are as follows: size of table, 4 by 15 inches; maximum table feed, 6 inches; maximum vertical travel of head, 5 inches; taper of spindle, No. 7 B. & S.; countershaft speed, 360 revolutions per minute; and available spindle speeds with three-step cone pulley, 120, 180, 270, 480, 720 and 1800 revolutions per minute.



No. 0 Bench Miller built by Morris Machine Tool Co.



"Sterling" Universal Tool Grinder built by Young, Corley & Dolan, Inc.

"STERLING" UNIVERSAL TOOL GRINDER

Young, Corley & Dolan, Inc., 149 Broadway, New York City, is now building the "Sterling" universal tool grinder which is completely universal in its movements and adapted for handling all classes of light grinding. The table revolves entirely around the head so that the wheel can engage the work at any desired angle. The spindle is hardened and ground, and runs in phosphor-bronze lined bearings, guards being provided to protect the bearings from abrasive dust. The knee is supported on gibbed V-slides which form part of a cylindrical member that may be completely revolved around the center column and locked in any angular position that is desired, after which the knee may be raised or lowered to the required position. This feature will be found very useful for die grinding where great accuracy is required. The head is secured to the center column around which swings the knee-carrying frame. The base of the machine forms a cabinet which is convenient for holding accessories used in connection with the machine, and it is made sufficiently heavy so that a rigid support is provided.

Felt washers are fitted on all bearings to guard against damage from abrasive dust. The work-table swings on a turntable 10 inches in diameter which can be rigidly locked at any desired angle to provide for performing taper grinding operations. The swivel frame is bored to fit the column and has a 45-degree slide for carrying the knee. The saddle slides on the knee are provided with adjustable gibs, and adequate protection has been made against the entrance of abrasive dust. The head is secured to the top of the column and is furnished with a graduated disk to enable the frame and knee to be swiveled around the column to any angle which may be required. The spindle is made of high-carbon steel, hardened and ground, and is 1 inch in diameter; it is supported in bearings lined with phosphor-bronze. The table travel is effected by means of a rack and pinion with adjustable stops to limit the movement in either direction; the table is 30 inches long;

the capacity between centers is 16 inches and the swing 9 inches.

The headstock is fully universal, provision being made for swiveling it both vertically and horizontally. Means are provided for driving on live or dead centers according to the requirements of the work. The tailstock is provided with a removable center and a clamping device. For those classes of work where internal grinding is necessary, an internal grinding attachment is provided which fits on the main head of the machine and is driven from a pulley fitted in place of one of the grinding wheels. Power table feed, with automatic reverse, can be supplied for use on this grinder, power being taken from the countershaft. The countershaft is equipped with a drum for driving the work. The following equipment is included with the machine: countershaft, universal headstock, tailstock with center, one sleeve, one center, one universal vise, one internal grinding attachment, one metal saw chuck, one universal three-jawed chuck, one set of dogs and the necessary wrenches for making all adjustments.

NEW MACHINERY AND TOOLS NOTES

Flexible Tubing: Worcester Flexible Tubing Co., Worcester, Mass. Metallic flexible tubing for use in conveying lubricant to the cutters used on various types of machine tools.

Pneumatic Drill: Baird Pneumatic Tool Co., Topeka, Kan. A tool especially designed for drilling "telltale" holes in locomotive boiler staybolts. It is suitable for operation at 1500 revolutions per minute and weighs less than four pounds.

Keyseating Tools: National Machine Tool Co., Cincinnati, Ohio. Tools for use in cutting keyseats in which the depth is 1½ times the width. The tools are used in a drilling machine, and the cutting is done by small milling cutters which complete the operation at a single cut.

Forcing Press: Charles F. Elmes Engineering Works, Chicago, Ill. A portable horizontal hydraulic forcing press designed for the performance of various forcing operations. The stroke of the ram is 24 inches, the pressure capacity 600 tons, and the weight of the press, 10,900 pounds.

Cutting-off Machine: Southwark Foundry & Machine Co., Philadelphia, Pa. An air-operated cutting-off machine for parting shell blanks from bar stock. The machine is suitable for operation on bars from 7 to 10 inches in diameter. The tools are fed into the work by compressed air, and three tools cut simultaneously.

Work Bench: Motor Engineering Co., East 61st and Curtiss Sts., Cleveland, Ohio. A work bench provided with a vise and drawer, and constructed in such a way that by loosening the screws that secure the wooden top to the steel legs, the bench may be taken apart for shipment or transfer to another part of the factory.

Engine Lathe: Rockefeller Motor Co., Cleveland, Ohio. The design of this machine is practically standard. It is equipped with double back-gears and a three-step cone pulley which provide a wide range of spindle speeds; and a quick-change feed-box provides an ample number of feed changes. This lathe is made in three sizes.

Clutch: Porter Machine Co., Wooster, Ohio. A disk pulley-type clutch in which the wear is taken up by a lining that may be easily renewed. When the clutch is released, sufficient clearance is provided to entirely eliminate drag. The clutch has a large friction surface, and engagement is gradual, while the release is instantaneous.

Floating Punch Press: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A punch press designed in such a way that the work is accurately centered, thus doing away with the necessity of reaming the punched holes. If the material to be punched is distorted, the punch floats with it, thus making adjustment of the cam ring unnecessary.

Heading Machine: Asa S. Cook Co., 603 Franklin Ave., Hartford, Conn. A heading machine equipped with a friction feed device which enables exactly the desired length of stock to be fed on every stroke of the feed arm. The machine is designed in such a way that the cut-off mechanism does not operate until all pressure has been removed from the punch.

Power Press: Consolidated Press Co., Hastings, Mich. A general-purpose power press designed for the performance of blanking and drawing operations. The frame is of a four-piece tie-rod type, and is held together by four steel rods which are shrunk into position. The frame is made in sections, tongued and grooved at the joints, and may be easily taken apart.

Universal Grinder: Simmons Machine Co., Albany, N. Y. A universal tool and cutter grinder designed to provide for handling a wide range of work. The headstock is fitted with bronze bushings, and micrometer adjustment is provided for all movements. A special countershaft is used in connection with the machine, which is of the "pull shift" type and easily operated.

Spring Forming Machine: Joseph T. Ryerson & Son, Chicago, Ill. An elliptic spring forming machine which has sufficient capacity for shaping spring leaves of all ordinary sizes. It consists of a horizontal table on which are mounted the forming dies and pressure cylinder. Adjustment is provided to set the dies for forming springs of various radii of curvature.

Soldering Press: James Donoghue, 1407 E. 111th St., Cleveland, Ohio. A power-driven machine for soldering sheets of tin plate into a continuous strip for roofing and similar purposes. The sheets have a lock turned on the edges so that they may be hooked together and fed into the machine; and as the sheets are hooked together, solder and flux are put on the seam.

Tool Grinder: Worcester Pattern & Model Co., Worcester, Mass. This grinder was particularly designed to meet the requirements of pattern shops, although it is also adapted for machine shop service where general tool grinding has to be done. When intended for use in a machine shop, the grinder is equipped with plain rests at both ends, and a buffing wheel may easily be attached.

Bar Straightening Machine: Medart Patent Pulley Co., St. Louis, Mo. An automatic machine especially designed for straightening and polishing steel shafting, although it is equally suitable for straightening iron, brass and bronze bars. The operation of the machine is continuous after the rolls have been set for a specified size of bar, and the rate of production is about 30 feet per minute.

Heavy Power Press: Consolidated Press Co., Hastings, Mich. A press especially designed for use in the production of brake drums for Ford motor cars, although it may be used for a variety of other automobile work. The machine is double geared, and the frame is tongued and grooved at every joint. The floor space occupied is 85 by 98 inches, and the weight of the press, approximately 30,000 pounds.

Rotary Punch Press: Malm Machine Co., Dayton, Ohio. A rotary punch press in which the punch and die drums are mounted on independent shafts. The punch drum is keyed to the punch driving shaft, while the die drum is mounted on an idler shaft which allows it to revolve freely. Multiple punches are mounted upon the punch drum, and these engage a similar number of dies mounted on the die drum.

Adjustable Drawing Table: G. A. Almorth, 966 Grand Ave., New Haven, Conn. A table in which the position of the drawing board can be adjusted to any angle to suit the work being done, and also to suit the stature of the draftsman who is using the table. The frame that supports the table is made of cast iron, and a cabinet furnished with three drawers and an ink bottle holder is secured to one side of the frame.

Slotter: Newton Machine Tool Works, Inc., Philadelphia, Pa. A crank-driven slotter equipped with a swiveling cutter-bar which may be adjusted to any angle up to 5 degrees on each side of the perpendicular. This adjustment makes the machine suitable for the performance of die-shaping operations. When used for tool-room work or the duplication of parts, positive stops are furnished for the cross and lateral table movements.

Balanced Hoist: Mann Corporation, Chicago, Ill. A hoist especially designed for handling shells and similar work in machine shops. The operator can attach the hook to a piece of work in the lathe or other machine, and at the same time fasten a second hook to a piece of work on the floor or truck. Then with comparatively little exertion, the finished piece is removed from the machine and the rough casting substituted in its place.

Multi-cone Clutch: Akron Gear & Engineering Co., Akron, Ohio. This clutch has three friction cones, the intermediate one of which is splined to the driving ring on the shaft; when the shifter is operated, one of the outer cones is first brought into contact with the intermediate cone, after which further movement of the shifter results in sliding these two cones into contact with the other outside cone. The clutch is then ready to transmit its full load.

Pneumatic Tapping and Drilling Machine: Baird Pneumatic Tool Co., Topeka, Kan. A machine designed for use in tapping staybolt holes and screwing the bolts into place. The machine may also be used for drilling and reaming holes, and for this service has a capacity for driving drills up to 1¼ inch in diameter. Working with an air pressure of 100 pounds per square inch, the tool runs at 175 revolutions per minute and develops 2½ horsepower.

Staybolt Cutter: Baird Pneumatic Tool Co., Topeka, Kan. A machine designed for the purpose of cutting locomotive boiler staybolts; but the use of suitable blades adapts the tool for cutting rivet heads also. It is operated with air at a working pressure of from 90 to 100 pounds per square inch, and

provides for leaving a sufficient amount of metal for the heading operation. Working on bolts from ¾ to 1⅛ inch in diameter, the capacity is about 1200 bolts per day.

Engine Lathe: Advance-Rumely Co., Laporte, Ind. A heavy-duty engine lathe designed to provide for taking the heaviest cuts that can be handled with high-speed steel cutting tools. The lathe swings 26 inches over the ways and 17 inches over the carriage; the capacity between centers is 48 inches; the back-gear ratio is 10.2 to 1; and the weight of the machine is 10,000 pounds. R. W. Baily, 122 S. Michigan Ave., Chicago, Ill., has the sales agency for the machine.

Bench Lathe: Walter H. Wade, 311 Atlantic Ave., Boston, Mass. This lathe was especially designed for tool-room work, but there are various other classes of precision work for which it is well suited. The bearings are made of tool steel, hardened and ground; and a quick-change gear-box is provided, which has a capacity for cutting 12 to 120 threads per inch. The machine may be driven either by a two-speed and reverse countershaft or by a friction countershaft.

Turret Lathe: Greenlee Bros. Co., Rockford, Ill. This machine swings 22 inches over the ways and 8 inches over the turret. The available speeds are from 12 to 280 revolutions per minute; and the available changes of feed are from 0.006 to 0.108 inch per revolution. The hole through the spindle is 3½ inches in diameter; and the weight of the machine is 6600 pounds. In general, the design is the same as that of the smaller sizes of turret lathes of this company's manufacture.

Surface Grinding Attachment for Milling Machine: Presto Machine Works, 119 Lafayette St., New York City. An attachment which provides for converting a horizontal milling machine into a surface grinder. The attachment is clamped to the over-arm, and the driving pulley is held between two bearings which provide adequate support for the grinding wheel spindle. The work-holding fixture is mounted on the table of the machine, which provides for traversing it under the grinding wheel.

Pneumatic Trip for Punches and Shears: Baird Pneumatic Tool Co., Topeka, Kan. A device intended for use in performing punching and shearing operations on large sheets, where it is impossible for the operator to reach the regular trip. For this purpose a small air cylinder is bolted to the side of the press frame and the piston in this cylinder is connected to the trip lever on the press. One pull of the trip cord, which is within easy reach of the operator, has the same effect as the application of pressure on the treadle.

Plain Grinding Machine: Perkins Grinder Co., 706 American Trust Bldg., Cleveland, Ohio. A 10- by 36-inch plain cylindrical grinding machine equipped with automatic and hand feeds. This machine is adapted for general manufacturing work and is self-contained, every unit, including the pump and tank, being an integral part of the machine. The maximum swing is 11 inches and the maximum capacity between centers is for work up to 40 inches in length. The control is centralized, all levers and handwheels being located at the front, within easy reach of the operator.

Manufacturing Milling Machine: Pratt & Whitney Co., Hartford, Conn. A milling machine of the "Lincoln" type especially adapted for use in the manufacture of gun parts and similar products. The table recedes from the work automatically during the return stroke; and it has a working surface 6½ inches wide by 18 inches long. The table and bed bearing surfaces are of equal length to give uniform wear. The maximum travel of the table is 12 inches, and in addition to a wide range of feeds, rapid power traverse is provided in each direction. The floor space occupied by the machine is 54 by 54 inches, and the weight, 3750 pounds.

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BALL BEARINGS ON FREIGHT CARS

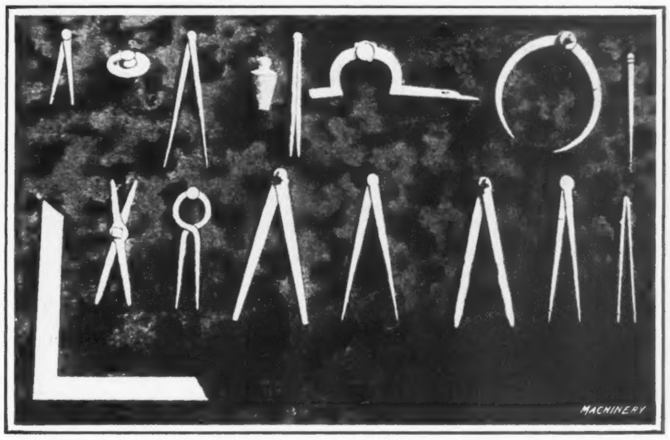
Fifty new ore cars have recently been completed for the Swedish state railways, which are all fitted with ball bearings. These cars will be used on the railway line in northern Sweden which carries the ore from the great Kiruna iron ore mines to the coast. This railway is electrically equipped, the traffic is exceedingly regular, and the conditions, in general, ideal for comparative trials of power consumption. It is proposed to run two trains, identical in equipment and loading, one composed of cars with ball bearings and one with ordinary plain bearings, and to measure the power consumption from day to day, by means of watt meters. The result of these trials will be of interest the world over for determining the value of ball bearings in railway equipment.

* * *

A match is a simple means for starting a fire, but in making the "Safe Home" match 211 operations are required from the wood in the forest to the finished product.

EARLY ROMAN TOOLS

At an exhibition held in connection with the National Retail Hardware Dealers' convention in Boston, June 14-16, the Brown & Sharpe Mfg. Co., Providence, R. I., included in its exhibits a panel of replicas of tools used by the Romans some two thousand years ago. They attracted considerable attention and will doubtless prove of interest to readers of MACHINERY. These are exact copies of certain instruments to be found in the National Museum in Naples. The originals were discovered among the ruins of the Roman city of Pompeii, just a few miles south of Naples, and represent the sort of tools used by architects and engineers, and perhaps too by the machinists of those far-off days when Pompeii and Herculaneum were overwhelmed by that gigantic earthquake in 63 A. D. The bronze instruments and works of art found in Pompeii are easily distinguished from those found in Herculaneum; those of Pompeii are oxidized and of a light bluish-green color; those of Herculaneum have a dark black-green hue, these distinctions being due to several causes, chief among which is the fact that ashes fell on Pompeii and flowing lava upon Herculaneum. In 1748 the discovery of some statues and bronze utensils by a peasant attracted the attention of the King of Naples; and excavations were then begun.



Replicas of Early Types of Roman Tools found in Excavations at Pompeii and Herculaneum

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PRESSURE OF FRICTION SCREW PRESSES—A CRITICISM

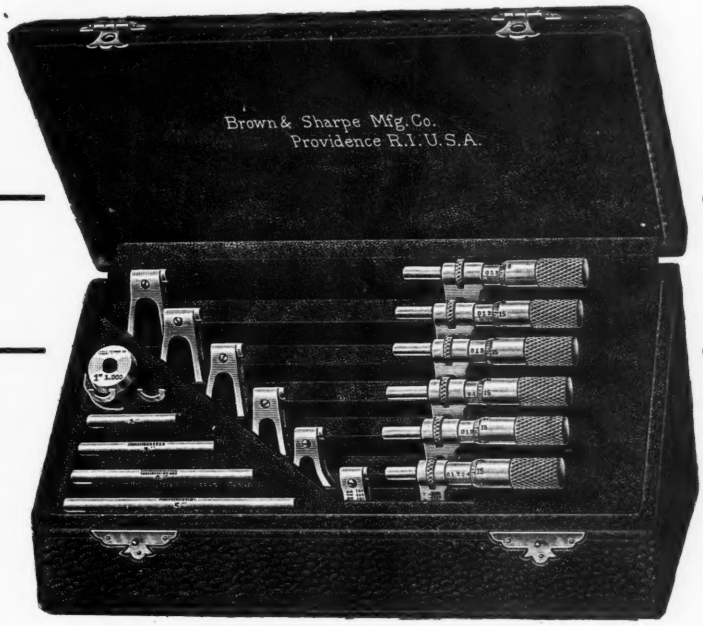
In the June number of MACHINERY, there appeared an article treating on the pressure developed by friction screw presses. While we furnished the author, at his request, some photographs of such presses as we manufacture, we do not wish to have it understood that the theory developed covers our conception of the subject. The author in no way fulfills his object "to give a clear understanding of the operation of this drive in connection with a screw-actuated ram." The author is also in error when he states that this press is almost a stranger in this country. It was, but it is quite at home now, since we have made a great many.

After lengthy deductions, and with the introduction of calculus, the author reaches this formula for the pressure exerted:

$$Q = ct$$

wherein c stands for a constant, and t for that part of the stroke that is actually doing the work. This formula says that the greater t is, the greater the pressure, and the smaller t is, the smaller the pressure. If, therefore, the empty press is tripped and the punch strikes the die without doing any work, $t = 0$, and the press should exert no pressure at all. Just the opposite is true, because in this case the press will exert its maximum pressure. A careful designer will, therefore, calculate the stresses for this extreme case. Having shown that the result of the author's deductions is wrong, it is hardly necessary to go into details, but other errors occur that challenge criticism. For instance, in figuring the speed of the flywheel, the circumferential speed is used instead of the speed of the center of gravity of the rim-section.

EDMUND W. ZEH,
Newark, N. J. Zeh & Hahnemann Co.



How About a Set of Reliable Micrometers—While Business is Good?

Why not place your order for that set of micrometer calipers you have been thinking of buying so long? The shop is busy, orders are coming in at a good rate, everybody is busy; but don't neglect your tool-room equipment. On the contrary, you should be even more careful about it now than ever. You are getting new business now that you want to keep. Better see to it that such work comes up to standard for accuracy—better provide good tools for checking it.

Brown & Sharpe Micrometer Calipers Meet Every Requirement for Tool Room or Inspection Use

So, if you are particular about quality, get in touch with the hardware dealer who carries the Brown & Sharpe line. He can furnish you with micrometer sets that are accurate and dependable and that give long service. How does a set like that shown above meet your requirements? With that in your tool room you are equipped to handle a wide range of work properly as far as checking its accuracy is concerned. We put up twelve different sets which meet a broad range of requirements. They are listed on pages 31-33, inclusive, of our No. 26 catalog. Have you a copy?

A line of our tools is also carried at our Chicago Store, 626-630 Washington Blvd., Chicago, Ill.

Providence, R. I., U. S. A.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; The E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine MachineryCo., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

FOREIGN TRADE POSSIBILITIES IN SOUTH AMERICA

At the meeting of the New York State Bankers' Association, Carlos Alfredo Tornquist, of Buenos Aires, said:

There is no reason why the United States should not be placed on a footing of equality with Europe in relation to Argentine finance and business. Nor is there any reason why the United States should not receive a share of the $250,000,000 or $300,000,000 which ordinarily goes into the coffers of European houses every year. But to obtain this trade, there must be closer personal contact between the Americans and the Argentines. The first necessity is the establishment of first-class, comfortable, and fast steamships that will make the trip between New York and Buenos Aires in twelve or fourteen days. Extended intercourse between the leaders of the respective communities—not of their secretaries and employes—also would do more to foster and augment international commerce than any number of conferences or publications. Although much of the extraordinary proportions lately reached in the trade between these two countries owes its existence to the war conditions, a great part of the advance has been the result of closer personal investigation and of the exercise of more vigorous efforts on the part of the Americans than were previously put forth.

In his report to the Department of Commerce on markets for machinery and machine tools in Argentina, J. A. Massel says:

This market at present offers good opportunities for the United States. But the exporter should realize that the South American nations are of Latin stock and that the language is chiefly Spanish. The average Latin-American, moreover, does not care for a short and dry business correspondent; he takes life more easily than the North American, and is averse to rushing matters. It is not sufficient, in Argentina, to demonstrate the superiority or advantages of an article; the salesman should, in addition, be pleasant and courteous in his conversation, and never, under any circumstances, aggressive or pushing. The principal reasons why the American so far has not had a market for his wares in that country is that very few houses have tried to adapt themselves to the business practices of Argentina. Practically all the important industries (the railroads, power plants, etc.) are in the hands of Europeans, while American capital is, in comparison, practically non-existent. Besides, Argentina finds a free and large market for its produce in Europe; while the European manufacturers have made every effort to secure this market which the Americans have neglected.

America's Share of Argentina's Foreign Trade

In 1913, which is the last year for which figures are available, Argentina imported 2300 adding and calculating machines, of which number 2088 were from the United States. Of 11,200 harrows, 2100 were bought in Germany and 8890 in the United States. Of 70,700 plows imported, 700 were from Canada, 2200 from Germany, and 66,000 from the United States. Of 10,600 reapers imported, 2000 were bought in Australia and 7300 in the United States. Of the 6300 typewriters received, 5300 were from the United States and 800 from Germany. The United States also sold 1200 of the 5100 automobiles purchased, France surpassing this country by selling 1800 cars. In nearly every other line France, Belgium, Germany, and Great Britain have surpassed this nation. Still, American goods are not disliked; the success of those lines in which an effort has been made to satisfy the people has shown that. The most successful and best-liked pipe cutting and threading tools are of American manufacture; they have almost completely displaced all others. They must cut the Whitworth thread, however.

Other Latin-American Countries

A careful study of the tariffs of the country to which the goods are sent is essential. When money is wanted for some new project, an added tax on imports is the normal thing in a number of South American states. In most of these countries, the appraiser is given all fines, or a part of all fines, that he may impose. In Argentina, he is recognized as the defendant, if the importer appeals from some ruling. In Chile and Peru, a bonus is paid to all custom-house employes instead of a share of the fines; while in Bolivia, the employes receive both a bonus and a share of the fines.

The Central Executive Council of the United States section of the International High Commission is urging the State Department to undertake the creation of gold trust funds in all the American nations similar to that maintained in this country by the Federal Reserve system. Secretary McAdoo says that such funds would greatly expedite commercial exchanges, saving unnecessary transfers of gold in the settlement of balances. The commissioners are also trying to secure the ratification of the uniform trademark, patent, copyright, and pecuniary claims treaties agreed on at Buenos Aires.

An effort is now being made to have a uniform educational system in all the Central American countries. Special attention is being paid to extending and improving rural schools and to giving practical courses in arts and trade to both men and women. It has been stated that over 4000 elementary schools have been opened in Mexico since the Carranza government was recognized by the United States.

Consul Homer Brett calls attention to the futility of trying to handle all South American business from one office, say, in Buenos Aires. A letter may be sent from Caracas, Venezuela, to New York and a reply received in twenty days, and a letter to Europe and its reply will require only thirty days; but it requires at least eighty days to send a letter to Buenos Aires and receive the reply.

In order to regulate the price of foreign exchange, the Bank of Venezuela has decided to discourage loans of every nature and to steadily decrease outstanding obligations. In its published statement of change of policy, it invites foreign capital to start banks for lending money to the people. The bank is now said to have about $1,500,000 in New York. The British Bank of South America states that there is a demand for imported goods in Brazil and Argentina, as the stocks are low, and that all goods are easily sold at high prices. The difficulty is rather in the delivery than in the selling of the goods.

D. E. J.

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ANNUAL CONVENTIONS M. C. B. A. AND A. R. M. M. A.

The fiftieth annual convention of the Master Car Builders' Association and the forty-ninth annual convention of the American Railway Master Mechanics' Association, were held in Atlantic City, N. J., June 14-16 and June 19-21, respectively. Saturday and Sunday, June 17 and 18, and the evenings of the convention days, were given over to the entertainment of the two bodies and their families. The sessions of the convention were held in Convention Hall on Young's Pier, and evening entertainments took place in the ballroom on the pier. Coincident with these two conventions, the Railway Supply Manufacturers' Association held its exhibit on Young's Pier, where 76,500 square feet was given over to the exhibition of different members. Of the 436 members, 260 exhibited. Unusual interest was taken by the delegates in the latest developments in railway supplies and shop equipment, and a spirit of optimism was in evidence everywhere. The machine tool exhibit was comparatively small, and some of the exhibiting companies maintained reception booths only, because of the difficulty of securing suitable machines to exhibit.

The program of the Master Car Builders' Association convention included the following:

June 14—Reports on standards and recommended practice; train brakes and signal equipment; brake shoe and track beam equipment; car wheels.

June 15—Reports on couplers; draft gear; safety appliances; loading rules; car construction; car trucks; train lighting and equipment.

June 16—Reports on tank cars; specifications and tests for materials; welding of truck sides and bolsters; election of officers.

The officers for the year were elected at this session as follows:

President, C. E. Chambers, superintendent of motive power, Central Railroad of New Jersey; first vice-president, T. W. Demarest, superintendent of motive power, Pennsylvania Lines Northwest of Pittsburg; second vice-president, James Coleman, superintendent car department, Grand Trunk Railway; third vice-president, G. W. Wildin, mechanical superintendent, New

York, New Haven & Hartford Railroad; treasurer, John S. Lentz, Lehigh Valley Railroad.

The American Railway Master Mechanics' Association sessions were held June 19, 20 and 21, and the synopsis of the program follows:

June 19—Reports on mechanical stokers; revision of standards; dimensions of injector couplings; paper on "Standardization of Screw Threads," by F. O. Wells; paper on "Tests of Four Types of Passenger Car Radiators," by Prof. A. J. Wood; topical discussion on metallic packing for superheater locomotives; report on fuel economy and smoke prevention.

June 20—Reports on locomotive headlights; design, construction and maintenance of locomotive boilers; superheated locomotives; equalization of long locomotives; design, maintenance and operation of electric rolling stock; design and material for piston valve rings and bearings; cooperation with other mechanical railway organizations; paper on "Alloy Steels," by L. R. Pomeroy; topical discussion, "Instructions to Young Firemen"; number of men to each instructor; recommended status of instructors.

June 21—Discussion of reports on powdered fuel; specifications and tests for materials; modernizing existing locomotives; train resistance and tonnage rating; topical discussion, "Best Method of Introducing Oil to Cylinders of Superheater Locomotives"; election of officers.

The following officers for the year were elected:

President, William Schlafge, general mechanical superintendent, Erie Railroad; first vice-president, F. H. Clark, general superintendent of motive power, Baltimore & Ohio Railroad; second vice-president, W. J. Tollerton, general mechanical superintendent, Chicago, Rock Island & Pacific Railroad; third vice-president, C. F. Giles, superintendent of machinery, Louisville & Nashville Railroad; treasurer, Angus Sinclair.

The annual meeting of the Railway Supply Manufacturers' Association was held Saturday noon in Convention Hall. At this session the following officers were elected: President, Edmund H. Walker, Standard Coupler Co.; vice-president, Le Grand Parish, American Arch Co.; secretary-treasurer, J. D. Conway.

Two hundred sixty members of the Railway Supply Manufacturers' Association exhibited or maintained reception booths. Among these were the following who exhibited machine tools, machine shop equipment or supplies:

Atkins & Co., E. C., Inc., Indianapolis, Ind. Circular and band metal cutting saws; hacksaw blades, frames and machines.

Besly & Co., C. H., Chicago, Ill. Reception booth; photographs of Besly grinders; samples of Besly staybolt taps, and Besly abrasive circles for disk grinders.

Carborundum Co., Niagara Falls, N. Y. "Carborundum" and "Aloxite" abrasive wheels.

Chicago Pneumatic Tool Co., Chicago, Ill. Pneumatic and electric tool and speed recorder.

Clipper Belt Lacer Co., Grand Rapids, Mich. Belt lacing machine.

Davis Machine Tool Co., Inc., Rochester, N. Y. 12-inch motor-driven lathe; 16-inch quick-change gear lathe; 24-inch turret lathe; 4½-inch cutting-off machine; keyseater; 16-inch shaper.

Duff Mfg. Co., Pittsburg, Pa. Ball-bearing screw jacks; car jacks, etc.

Gibb Instrument Co., Pittsburg, Pa. "I-Rite" optical pyrometer.

Gilbert & Barker Mfg. Co., Springfield, Mass. Lubricating pumps and outfits.

Greene, Tweed & Co., New York City. Packing for piston rods, valves, pumps, etc.; "Favorite" reversible ratchet wrench.

Greenfield Tap & Die Corporation, Greenfield, Mass. Screw cutting tools, taps, dies, reamers, gages, automatic die-heads, etc.

Haring, Ellsworth, New York City. High-speed, alloy and carbon steels, and specialties.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Complete line of chain hoists.

Independent Pneumatic Tool Co., Chicago, Ill. Reception booth.

Ingersoll-Rand Co., New York City. Pneumatic chipping, scaling and riveting hammers; pneumatic drills; motor hoists.

Johns-Manville Co., H. W., New York City. Pipe coverings; asbestos roofing, etc.

Keller Mechanical Engraving Co., Brooklyn, N. Y. Automatic die-sinking machine.

Keller Pneumatic Tool Co., Chicago, Ill. Pneumatic tools.

Lubricating Metal Co., New York City. "Noheet" bearing metal; die-cast bearings; piston and ring packing.

Milburn Co., Alex., Baltimore, Md. Acetylene welding and cutting outfits.

National Tube Co., Pittsburg, Pa. Reception booth.

Nuttall Co., R. D., Pittsburg, Pa. Gears; flexible couplings; expansion joints.

Nutter & Barnes Co., Hinsdale, N. H. Metal cutting-off saw; saw sharpener; abrasive cutting-off machine.

Phoenix Mfg. Co., Eau Claire, Wis. "Conradson" turret; turret toolposts.

Quigley Furnace Specialties Co., Inc., New York City. Demonstration of "Hy-tempite" furnace cement.

Rich Tool Co., Chicago, Ill. Reamers, drills, and rivet sets.

Simonds Mfg. Co., Fitchburg, Mass. Hacksaw blades; metal cutting saws; files.

Warner & Swasey Co., Cleveland, Ohio. 2-A hollow hexagon turret lathe for bar work; 3-A hollow hexagon turret lathe for chucking work.

Watson-Stillman Co., New York City. Hydraulic jacks.

Wilson Welder & Metals Co., Inc., New York City. Electric welding equipment.

Yale & Towne Mfg. Co., New York City. Chain hoists; trolleys; electric hoists; locks.

PERSONALS

A. F. Orcutt has been appointed general manager of the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.

C. A. Towle has been appointed production manager of the factory of the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.

W. Wetsel, who has for some time been associated with the Baush Machine Tool Co., at Springfield, Mass., will be in charge of the company's new office, located in the Dime Bank Bldg., Detroit, Mich.

O. Bruenauer, Western sales manager of the Gurney Ball Bearing Co., located at Detroit, has removed to the home office at Jamestown, N. Y., to assume the duties of general sales and advertising manager.

H. C. Burdick, for three years assistant advertising manager of the American Multigraph Co., Cleveland, Ohio, has taken the position as advertising manager of the Glidden Varnish Co., Cleveland.

D. W. Patten, for several years with the Windsor Machine Co., Windsor, Vt. (now the National-Acme Mfg. Co.), selling the Gridley automatic lathe in Ohio, will represent the New Britain Machine Co., New Britain, Conn., in the same territory.

F. R. Blair, formerly secretary, treasurer and sales manager of the S. K. F. Ball Bearing Co., has resigned to become president of F. R. Blair & Co., Inc., with offices at 50 Church St., New York City. Mr. Blair will be engaged in developing motor efficiency devices.

Isaac H. Levin has resigned as chief engineer and chemist of the International Oxygen Co., and will from now on devote his time to chemical research as a specialist in the electrolytic field. Mr. Levin will be located temporarily at 186 Hillside Ave., Newark, N. J.

Henry M. Shaw, formerly Eastern representative of the Gardner Machine Co., Beloit, Wis., has joined the Sherritt & Stoer Co., Inc., 603 Finance Bldg., Philadelphia, Pa., and will represent the company in the sale of machine tools, railway and machine shop equipment, giving special attention to the Gardner Machine Co.'s products.

Alexander Luchars, publisher of MACHINERY, sailed for Liverpool on the *Kroonland* on June 29, and will be abroad several months. He expects to visit England, Holland, Switzerland, Italy, France and Germany, to study conditions in the machine tool and kindred industries, and form some opinion regarding the outlook in the machinery field after the war closes.

Walter N. Polakov, recently superintendent of power of the New York, New Haven & Hartford Railroad, and consulting engineer to the Board of Estimate and Apportionment of the city of New York, is now directing the work of David Vershbinsky, Inc., engineer and exporter, 31 Nassau St., New York City. Mr. Polakov will also act as consulting engineer for the management of power plants.

C. F. Herington, assistant engineer in the office of the mechanical engineer of the New York Central Railroad, has resigned to take a position with the Bonnot Co., Canton, Ohio, as mechanical engineer of the powdered coal department. Mr. Herington's experience with the New York Central Railroad, Pennsylvania Railroad, and Westinghouse, Church, Kerr & Co., with whom he has been associated for the past twelve years, should prove of value to him in his new position.

Dr. Robert Gans of Pankow, near Berlin, Germany, has been awarded the Elliott Cresson gold medal by the Franklin Institute for his discovery and development of "Permutit." Permutit is sodium-alumino-silicate used for softening water, having the remarkable property of exchanging its sodium for the hardening ingredients—calcium and magnesium—in water filtered through it. When the "Permutit" has been exhausted of its sodium, it may be regenerated with a solution of common salt.

F. E. Wells, formerly president of the F. E. Wells & Son Co., Greenfield, Mass., manufacturer of machinery, taps, dies, etc., has retired from business, after fifty years of active work. Mr. Wells started in the cutlery business in 1866, later engaged in the paper business and in 1873 was identified with the Wiley & Russell Mfg. Co. Later in company with his father and F. O. Wells, he started the Wells Bros. Co. In 1900 he sold his interest in the Wells Bros. Co., and with Fred W. Wells, his son, started the present business. F. O. Wells, F. H. Payne and W. M. Pratt have lately taken a controlling interest in the company.

OBITUARIES

Einar G. Lindstrom, production manager of the Putnam Machine Co., Fitchburg, Mass., was killed instantly in an automobile accident June 15. Mr. Lindstrom leaves a wife and four children.

John D. Hughes, superintendent of the Putnam Machine Co., Fitchburg, Mass., was killed in an automobile accident June 15. Mr. Hughes was forty-two years of age, and is survived by his wife.

COMING EVENTS

July 27.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Delaware College, Newark, Del. Catalogue 1915-1916 with announcements for 1916-1917.

University of Vermont, Burlington, Vt. Catalogue for 1915-1916, with announcements for 1916-1917.

Louisiana State University, Baton Rouge, La. Catalogue 1915-1916, with announcements for 1916-1917.

Thomas S. Clarkson Memorial College, Potsdam, N. Y. Bulletin containing views of the various departments of the college.

Pratt Institute, Brooklyn, N. Y. Catalogue 1915-1916, containing calendar for 1915-1916 and general information regarding courses.

University of Nebraska, Lincoln, Neb. Forty-sixth annual general catalogue containing complete record for 1915-1916 and announcements for 1916-1917.

American Association of Labor Legislation, 131 E. 23rd St., New York City. Booklet entitled "Health Insurance," containing standards and tentative draft of an act submitted for criticism and discussion of those interested in compulsory insurance of workmen against sickness.

State Normal and Training School, Buffalo, N. Y. Circular of information concerning courses for training vocational teachers, 1916-1917. The vocational work is grouped under two general heads, trade group and book work group, the former qualifying for teaching the trades themselves and the latter for teaching book work, applied science, industrial geography, history, mathematics, etc., which are correlated with the hand work in the best types of vocational schools. The school is prepared to give pedagogical training for teaching most of the recognized skilled trades.

NEW BOOKS AND PAMPHLETS

An Investigation of the Laws of Plastic Flow. By Eugene C. Bingham. 43 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 278.

Strength and Stiffness of Steel Under Biaxial Loading. By Albert J. Becker. 65 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 85. Price, 35 cents.

Tests of Reinforced Concrete Flat Slab Structures. By Arthur N. Talbot and Willis A. Slater. 128 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 84. Price, 65 cents.

Constants of the Quartz-wedge Saccharimeter and the Specific Rotation of Sucrose. By Frederick Bates and Richard F. Jackson. 60 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 268.

Weights and Measures. 254 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C.

This booklet contains the proceedings of the tenth annual conference of representatives from various states held at the Bureau of Standards, Washington, D. C., May 25-28, 1915.

Industrial Accident Prevention. 54 pages, 6 by 9 inches. Published by the Department of Labor, under the direction of the Industrial Commission, Washington, D. C., as Special Bulletin 77.

This bulletin takes up accident prevention experience and reproduces a number of charts showing graphically the accident experience of various large companies. It discusses means of preventing accidents under the following heads: nature of the problem; responsibility of employer, responsibility of foremen, safety and output, mechanical guards, shop housekeeping, industrial hygiene, fatigue and safety, welfare work and safety, responsibility of employe, the mental hazard, educating the new man, need for safety education, safety advertising, discipline, organization, workmen's committees, suggestions from workmen, investigation of accidents, score-board competition, selection of men, functions of medical department, first aid, protection of eyes, miscellaneous causes of accidents.

Workshop Hints for Munition Workers. By Bernard E. Jones. 156 pages, 5 by 7¼ inches. Illustrated. Published in America by Funk & Wagnalls Co., New York City. Price, 50 cents; by mail, 58 cents.

This is an elementary work intended for the instruction of munition workers who have had no mechanical experience and are unfamiliar with mechanical terms and processes generally. The common tools and machines are illustrated and described, such as hammers, hacksaws, spanners, files, scrapers, lathes, drills, calipers, micrometers, wire gages, milling machines, gear cutters, grinding machines, etc. The operations of forging, scraping, centering, turning, boring, taper turning, drilling, milling, screw cutting and measuring are illustrated and described in the simplest terms. The work is compiled largely from articles contributed to an English publication called "Work," and the methods described pertain to British practice generally.

Mechanical Engineers' Handbook. Editor-in-Chief, Lionel S. Marks. 1836 pages, 4½ by 7 inches. Published by the McGraw-Hill Book Co., New York City. Price, $5.

This handbook is based on the well-known German engineering handbook generally referred to as "Hutte," and is intended to present in the English language an authoritative reference book covering the field of mechanical engineering in a comprehensive manner. It differs, therefore, very materially from previously published American handbooks in that it deals more thoroughly with the theoretical basis of engineering, devoting 186 pages, as it does, to the subject of mathematical tables and mathematics, and nearly 200 pages to mechanics and thermo-dynamics. The following sections of the work deal with strength of materials, materials of engineering, machine elements, power generation, hoisting and conveying, transportation, building construction and equipment, machine shop practice, pumps and compressors, electrical engineering, engineering measurements, mechanical refrigeration, and miscellaneous subjects. In the preparation of this work the editor-in-chief has been assisted by a staff of about fifty specialists, and the work gives the appearance of having been prepared with considerable care; but much of the contents indicates clearly that the editor and his collaborators had in mind mainly the technically trained mechanical engineer rather than the practically trained man when preparing this handbook, and for men of the former type it will undoubtedly prove the most comprehensive and authoritative book of its kind published in English. To obtain full benefit from the work, however, the user must possess considerable engineering training. The information given on machine tools and machine shop practice occupies about seventy pages of the work and contains many valuable tables, but the text matter is rather too abbreviated to convey much detailed information. However, in a work of this kind this may not be considered necessary, as it aims to cover briefly the whole field of mechanical engineering, and those wishing to obtain detailed information upon such subjects as machine shop practice would seek that in books specifically devoted to that subject.

NEW CATALOGUES AND CIRCULARS

Russell Mfg. Co., Greenfield, Mass. Catalogue 2 on Russell opening-die screw plates, double reversible-die screw plates, full mounted screw plates, etc.

Yeomans Bros. Co., 231 Institute Place, Chicago, Ill. Bulletin S 1000, descriptive of small electrically driven centrifugal pumps for all classes of buildings.

Davis Machine Tool Co., Inc., Rochester, N. Y. General catalogue of engine lathes, turret lathes, tool-room lathes, cutting-off machines, keyseaters, shapers, and drilling machines.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 48906 illustrating and describing Sprague electric S-1 hoists of one-half and one ton capacities.

Perkins Grinder Co., American Trust Bldg., Cleveland, Ohio. Circular describing the Perkins 10 by 36 plain self-contained grinding machine with center control and automatic and hand feeds.

Pierce Machine Tool Co., 617 W. Jackson Blvd., Chicago, Ill. Circulars illustrating Pierce 1- by 8-inch heavy-pattern turret screw machine with plain head, and 14-inch heavy-pattern turret lathe with plain head.

Rockefeller Motor Co., 2279 Clarkwood Road, Cleveland, Ohio. Bulletin 10 of "Perfection" engine lathes made in three sizes, 16-inch swing with 6-foot bed, 18-inch swing with 8-foot bed, and 20-inch swing with 10-foot bed.

Chain Belt Co., Milwaukee, Wis. Folder 64 describing Chain-Belt traveling water screens, designed primarily to remove refuse and foreign material from water before it enters power plants, steel mills or other industrial plants.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Catalogue 14, entitled "The Vital Factor in Cutting," illustrating "Red-E" lathe tools, threading tools, cutting-off tools, side tools, boring tool-holders, milling machine dogs, lathe dogs, etc.

Schuchardt & Schutte, 90 West St., New York City. Circular of the S. & S. tachoscope, a precision revolution counter combined with anti-magnetic stop watch. The instrument may be used for speeds up to 30,000 revolutions per minute.

Lansing Stamping & Tool Co., Lansing, Mich. Bulletin 2 of the "Capital" internal grinder, having a capacity of from 3/16 inch to 2 by 2 inches. The wheel-spindle is mounted in S. K. F. ball bearings, and is capable of being run at 30,000 revolutions per minute.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Revised discount sheet applying to prices quoted in Cutler-Hammer catalogue, which has the effect of raising the present prices approximately 10 per cent. This has been made necessary by the increase in cost of material.

J. R. Shays, Jr., 47 W. 34th St., New York City. Folder descriptive of the Lloyd flexible coupling for use in connection with direct-connected motor-driven apparatus. The circular gives a table of prices, dimensions and ratings, and will be sent upon request to those interested.

Webster & Perks Tool Co., Springfield, Ohio. Catalogue of bolt pointing, threading and special tapping machines. The threading machines are made with one, two, four and six spindles, and in a special duplex type designed to thread both ends of small studs, clips, etc., simultaneously.

New Departure Mfg. Co., Bristol, Conn. Sheets 67 FE to 70 FE and table of contents for loose-leaf catalogue, describing cylinder block boring machine head, turbine-driven forced draft blower, ball bearing roller mill for milling flour and reversing and change-speed gear head for lathe.

C. W. Hunt Co., Inc., West New Brighton, N. Y. Catalogue 15-3 illustrating and describing Hunt cut-off valves for controlling the flow of coal, ashes, coke, ore, stone, sand, gravel, cement clinker etc. Dimensions are given for the types most frequently used in power-house and storage-pocket design.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 12 discusses the possibilities of the forging machine for producing accurate work and illustrates dies used on National heavy-pattern forging machines for producing taper ring forgings within a close limit of tolerance.

E. J. Codd Co., 700-708 S. Caroline St., Baltimore, Md. Circular of the Wiegand chain screen door for furnaces, ovens and boilers, illustrating and describing a novel and simple chain screen for keeping the heat in and the cold air out when examining the interior of a furnace or supplying fuel.

Kales-Haskel Co., 443 Lafayette Blvd., Detroit, Mich. Circular illustrating special lock washers, metal cups and shells, bearing liners and shims, pipe and wire clips, etc., and containing a list of special washer dies, made in sizes from 3/64 inch inside diameter by 1/4 inch outside diameter to 13 inches inside diameter by 14½ inches outside diameter.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Circular 502 illustrating "Jorgensen" adjustable hand screws with jaws that are adjustable to any angle and steel spindles cut with right and left threads. The provision of right and left threads permits opening and closing the jaws much more rapidly than with the old-style clamps.

Carrier Air Conditioning Co. of America, Buffalo, N. Y. Bulletin 253, entitled "Generator Cooling and Cleaning," describing the construction of the Carrier generator cooler and the benefits obtained in cooling and cleaning the air supply for ventila-

tion of turbo-generators. Special attention has been paid to the design of the spray nozzles which are of the non-clogging type.

Fawcus Machine Co., Pittsburg, Pa. Catalogue of Fawcus herringbone gears, stating the advantages of this type of gear, and describing the hobbing process and Fawcus planed gears for rolling mill connecting pinions and very large drives. Fawcus herringbone gear drives and turbine transmissions are illustrated, and tables of dimensions for standard mill drives are given, as well as other data of use in designing herringbone gears.

Strong, Kennard & Nutt Co., 507-521 Schofield Bldg., Cleveland, Ohio. Pamphlet illustrating and describing "Adjustoglas" safety goggles, for protecting the eyes of workmen against heat and flying particles. The "Adjustoglas" goggle is made with a bridge which is adjustable for width and height, and can be adjusted to any angle or any distance from the face. This insures a comfortable protector which will fit any wearer.

Cincinnati Lubricant Pump Co., 126 Opera Place, Cincinnati, Ohio. Circular describing the "Fulflo" grinder pump, a circulating pump which is centrifugal in its action, assuring a large volume of flow without too much pressure. The pump does not need to be submerged or placed below the level of the liquid, and hence can be mounted in the most desirable position on the grinder with regard to convenience of drive and accessibility.

Joseph T. Ryerson & Son, Chicago, Ill. Bulletin 20141 descriptive of the "Riley" universal elliptic spring forming machine, which will form elliptic spring leaves of any size and curvature that are used in ordinary practice, without changing dies. This machine was primarily designed for railroad spring shop use, and in addition to making springs it can also be used for straightening old plates or shaping other articles used about a railroad shop.

L. S. Starrett Co., Athol, Mass. Catalogue 21, containing 336 pages and having sixteen more pages than catalogue 20. Some of the new Starrett tools shown are quick-reading steel rules, metric steel shrink rules, three-foot blacksmiths' steel rules, metric and English blacksmiths' steel rules, metric and English folding pocket rules, drop-forged steel combination squares with metric and English graduations, improved bevel protractors with metric and English graduations, diemaker's square, pocket vernier caliper, "Yankee" one-inch micrometer caliper, vernier height gage, adjustable hacksaw frames, cutting nippers, cutting pliers and drive-pin punches. The prices of tools listed in catalogue 20 no longer hold, and users of Starrett tools should obtain catalogue 21 in order to get the revised prices.

Norton Co., Worcester, Mass. Catalogue of grinding wheels and machinery, giving price lists of straight, cup and cylinder wheels, and illustrating a great variety of shapes of these classes of wheels. There are fifty-five pages of illustrations showing shapes of grinding wheels for use in special machines. In addition, the catalogue contains information on selecting grades of wheels for various classes of work, methods of mounting grinding wheels, speeds of grinding wheels, horsepower required to drive wheels of different sizes, calculating speeds and diameters of pulleys, etc. Crystolon wheels for grinding leather, pearl, granite and marble are illustrated, with specimens of work, as well as alundum wheels for glass cutting. Price lists are also given for alundum and crystolon bricks, used principally for scouring castings, general foundry and machine shop work, dressing and smoothing granite and marble, etc. The Norton line also includes oilstones, valve grinding compounds, dressers, cylinder chucks, grinding wheel stands, protection and dust hoods and countershafts.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Anniversary booklet entitled "One Century in Business," describing the development and growth of the company from its inception in 1816 to the present. The business was established at 95 Fair St. (Fulton St.) by Henri Frederic Frasse, who started as a dealer in watch and clockmakers' supplies and repairer. A store was opened in conjunction with the machine shop in which was carried a complete and varied stock of jewelers' supplies and imported fine tools, consisting of files, pliers, nippers, etc. Upon the death of Henri Frasse in 1849 the business was taken over by his son, Peter A. Frasse, under whose name it is now carried on. Later the stock was increased until a complete line of machinists' tools of both foreign and American manufacture was handled, including vises, forges, blacksmiths' tools, etc. In 1900 the Shelby seamless steel tubing department was added to the business. With the outbreak of the present war, the firm was obliged to discontinue its agency of the Poldi Steel Works, and in order to take care of its customers, it began the manufacture of a complete line of electric furnace and open-hearth tool and alloy steels. The story of the growth of this business, which is so closely connected with the growth and development of the country in general, makes interesting reading, and the book, which has been carefully and artistically prepared, is a creditable souvenir of "one century in business."

TRADE NOTES

Bickford Machine Co. has moved from 12 Chapman St. to 305 Wells St., Greenfield, Mass.

Rickert-Shafer Co., formerly located at 1302 Peach St., Erie, Pa., has moved to 612 W. 12th St.

W. Robertson Machine & Foundry Co. has recently moved into its new factory at 32 Greenwood Place, Buffalo, N. Y.

Carlton Machine Tool Co., 1543 Queen City Ave., Cincinnati, Ohio, is successor to the William E. Gang Co., manufacturer of radial drills.

Abrasive Material Co., Philadelphia, Pa., manufacturer of "Abrasive" and "Boro-carbone" grinding wheels, has changed its name to Abrasive Co.

Young, Corley & Dolan, Inc., machine tool dealers, 149 Broadway, New York City, moved July 1 to more spacious quarters on the eighth floor of the U. S. Realty Bldg.

Standard Electric Tool Co., Cincinnati, Ohio, has doubled its manufacturing capacity by the addition of another floor. The business has grown steadily since its beginning.

Mann Corporation, Kankakee, Ill., recently took over the rights of manufacture and sale of the American sash trimmer formerly made by the Heald Machine Co., Worcester, Mass.

Cincinnati Lathe & Tool Co., Cincinnati, Ohio, manufacturer of the "Cincinnati" lathe, is erecting a large addition to its plant which is expected to be ready for operation early in July.

Cincinnati Lubricant Pump Co., Cincinnati, Ohio, maker of the "Fulflo" pumps for machine tool lubrication, has moved from 2270 Spring Grove Ave. to larger quarters at 126 Opera Place.

Van Dorn & Dutton Co., 2706 E. 79th St., Cleveland, Ohio, gear manufacturer, announces the removal of its Denver, Col. offices from the Ideal Bldg., to 1633 Tremont St. C. H. Davidson is the district sales manager.

Schellenbach & Hunt Tool Co., Cincinnati, Ohio, manufacturer of reamers, end-mills, boring tools and cutters, has erected a large addition to its shop which will double the capacity. The business of the company is rapidly growing.

Moltrup Steel Products Co., Beaver Falls, Pa., manufacturer of cold-drawn steel bars, machine keys and racks, finished steel plate and other steel specialties, is erecting a three-story addition to its factory which will triple the present output.

New England Annealing & Tool Co.'s factory at 74 K St., S. Boston, Mass., was destroyed by fire May 24. The company expects, by using a temporary shelter, to be able to use its annealing furnaces until its plans for rebuilding are completed.

International Oxygen Co., 115 Broadway, New York City, recently received an order from Franz Krull, Ltd., Reval, Russia, for a large oxy-hydrogen plant of the unit type generators. The gases produced by this plant are to be used for welding and piped throughout the works.

National Twist Drill & Machine Co., Detroit, Mich., is erecting a three-story concrete and brick office building 42 by 81 feet, and a four-story addition 40 by 19 feet, with L-connection to the present structure 36 by 38 feet. These additions will practically double the present floor space.

Kearney & Trecker Co., Milwaukee, Wis., has completed the addition of two sawtooth roof sections to its plant, 65 by 250 feet. One bay is equipped with a traveling crane and will be used for erection. The new addition and another recently completed add over 20,000 square feet of floor space.

Keuffel & Esser Co., Hoboken, N. J., was rendered a favorable decision by the United States Circuit Court of Appeals in its suit against the distributors of the Shepard pen. The decision upheld the validity of the Keuffel & Esser patent on the Payzant lettering pen and held the Shepard pen to be an infringement.

Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., announces that it has opened an office in the Dime Bank Bldg., Detroit, Mich. W. Wetsel, who has been associated with this company for some time, and who is familiar with all the lines manufactured by the company, including worm-gears for automobiles, will be in charge of the office.

National Scale Co., 6 Mechanic St., Chicopee Falls, Mass., has moved its New York agency from 13 Park Row to 20 Vesey St., Room 309. H. S. Trezevant is in charge. The company manufactures the "National" counting machines, "National-Chapman" elevating trucks, "National" calling system, multi-unit sectional steel shelving and metal stampings.

Lucas Machine Tool Co., Cleveland, Ohio, is building a new erecting shop, 47 by 180 feet, equipped with a 15-ton traveling crane. The present sawtooth sections of the plant open into the addition, and the crane runways of the former are extended sufficiently to permit work to be shifted from the sawtooth section floors to the erecting floor or vice versa by the cranes.

Cincinnati Screw Co., Twightwee, Ohio, has increased its capital stock to $200,000, $100,000 of which is common stock and the remainder accumulated 7 per cent preferred. The plant is growing rapidly and is being operated night and day. The company has found it necessary to expand its equipment in order to take care of the increasing volume of business, and has recently placed orders for a large number of machine tools.

Forest City Machine & Forge Co., 5110 Lakeside Ave., Cleveland, Ohio, lately erected a machine shop 100 feet wide and 226 feet long. The walls are of brick and steel sash. The cross-section is standard, one line of columns down the center supporting fifty-foot trusses and monitor trusses. The building was erected by the Samuel Austin & Son Co. of Cleveland, and was completed in fifteen working days, the work being started May 18 and being practically done June 2.

Canton Foundry & Machine Co., Canton, Ohio, maker of alligator shears, automobile turntables, industrial shop turntables, portable floor cranes and hoists and sheet metal machinery, is building a new shop for the manufacture of its portable cranes. The blacksmith department will also be located in this building. The company is contemplating further extension of its plant, comprising a new and much larger foundry and an addition to the machine shop, which will increase its capacity about 75 per cent.

Silvex Co., Bethlehem, Pa., manufacturer of the Bethlehem spark plug and shock absorbers, is building a new factory, one-story high, covering an area of 315 by 60 feet. There will be a basement under one end extending back 150 feet. It is expected that the plant will have a capacity of 10,000 spark plugs per day with sufficient space to increase the output 50 per cent without enlarging the building. The capacity for shock absorbers will also be 10,000 per year. W. S. Barstow & Co., 50 Pine St., New York City, are the designers and engineers.

L. H. Gilmer Co., Tacony, Philadelphia, Pa., manufacturer of endless belts, belting, webbing, tape, etc., has terminated the arrangement that has existed for a number of years with the R. B. Ridgley Co. of Detroit, Mich., and has opened a branch office in Detroit at 965 Woodward Ave., Hayward Bldg., in charge of W. S. Lewis, who has been assistant purchasing agent for the Cadillac Motor Car Co. for a number of years. The change has been found advisable owing to the heavy increase in the volume of business in the Detroit territory.

R. Martens & Co., Inc., New York City, have leased the new city pier at Stapleton, S. I., for a period of thirty years, at an annual rental of $42,000 for the first ten years, with increasing rental for each succeeding ten years. This pier is 1300 feet long and will accommodate four average sized cargo steamers at one time. The company is developing Russian-American trade, and in view of the great possibilities in that field for goods of American manufacture, the new pier was acquired to take care of the business. An enormous quantity of freight is already piled up on the pier.

F. E. Wells & Son Co., Greenfield, Mass., has been purchased by F. O. Wells, W. M. Pratt and F. H. Payne. The new officers of the company are F. O. Wells, president; F. H. Payne, vice-president; and Frank A. Yeaw, treasurer. These men, together with W. M. Pratt and Fred W. Wells, will constitute the board of directors. The business was established by F. E. Wells, and Mr. Wells, while retaining an interest in the company, now retires from active business. The company manufactures machinery, speed lathes, grinders, screw machines, tapping machines, as well as pipe tools, screw plates, taps, dies and similar tools.

Norma Co. of America, 1790 Broadway, New York City, manufacturer of "Norma" ball bearings, has purchased a ten-acre factory site at Elmhurst, L. I., on the outskirts of Long Island City. The property fronts on Queens Boulevard, and abuts in the rear upon the main line of the Long Island Railroad, from which a siding will be built directly into the plant. Plans are being made for the erection of a four-story building 70 by 350 feet, to be constructed of reinforced concrete. During the past five years the company has become prominently identified with the automobile industry as a maker of ball bearings, and its bearings are being extensively used in magnetos, lighting generators, etc.

Gisholt Machine Co., Madison, Wis., has recently extended its manufacturing facilities by the purchase of the Northern Electric plant in Madison, owned by the General Electric Co. The plant is of brick and steel construction, well lighted and heated and provided with a sprinkling system throughout. The equipment is modern, and all the machine tools are motor driven. The company also has works at Warren, Pa., where the Gisholt universal tool grinders and vertical boring mills are built. The Madison works will continue to build hand and automatic Gisholt turret lathes, horizontal boring and drilling machines, reamers, boring-bars, tool-holders, chucks and the special tool equipment used on Gisholt machines generally.

CLASSIFIED AND WANT ADVERTISEMENTS

Will be found on pages 292-293 of this issue and will be run in the same relative position in future.